Docket No.: **582/9-1477**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant: Albert BAUER

Serial No.: 08/998,507 Group Art Unit: 3743

Filed: December 26, 1997 Examiner: John Ford

For: AIR CONDITIONING APPARATUS

Commissioner for Patents
Washington, DC 20231

RESPONSE TO ORDER UNDER 37 CFR 41.50(d)

Sir:

This is a response to the order issued by the Board of Patent Appeals and Interferences on June 9, 2006, under 37 CFR 41.50(d). The following answer tracks the numbered requests presented in the order.

(1) The appellant confirms that the entire recitation “means for regulating an increase in pressure in the at least one room relative to an outside pressure, to vary the pressure in correspondence to the selected room temperature” is a means plus function recitation under 35 USC 112, sixth paragraph.

It is necessary that the recitation, “to vary the room pressure in correspondence to the selected room temperature” be part of the means plus function recitation, since this confirms the specific function of the means, not merely an intended use, as the means must provide for the dynamic inter-relationship of room temperature and pressure.

For reference, the Board may consider Toro Co. v. Deere & Co., 355 F.3d 1313, 1323

(Fed. Cir. 2004), where the following was determined to being a proper means plus function recitation: "control means connecting said pressurized fluid generating means to the input ports of each said nozzles so as to produce periodic fluid injections from the output port of each said nozzle."(Emphasis added). The district court concluded this clause was written in means-plus-function format pursuant to 35 U.S.C. § 112 P 6, with the function "involving the controlled production of periodic fluid injections to the input ports of the individual nozzles so as to produce the periodic fluid dispersions from the output port of each nozzle." Toro Co., 143 F. Supp. 2d at 1130. The Federal Circuit agreed with the district court's conclusion.

The language here is comparable, as it could as easily be stated "so as to vary the room pressure in correspondence to the selected room temperature." Here, as in Toro, the qualification of the function performed is a necessary part of the means plus function recitation.

(2)(a) The Board requested reference to specific structure for performing the stated function. The specific structure may be found by reference to the drawings. (Note the figures presented are from continuation application no. 10/273,068, (See Evidence Appendix) where formal drawings were filed. These are clearer and are presented for ease in illustration only. As a continuation, the drawings contain the same information, and no new matter is involved in their use.) An excerpt from Fig. 2 follows:

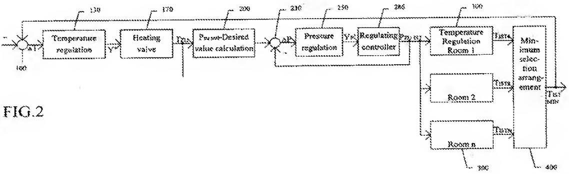
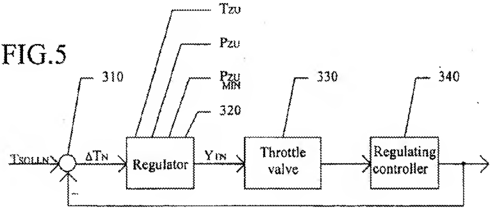


FIG.2

Note that the temperature control elements work with the heating valve to increase the supply air temperature T_{ZU}, but also, the temperature difference is used to initiate a pressure change in the room. For example, if the room temperature is below a set/selected temperature (such as 68 vs 72 °F) the difference in temperature is determined, as an error signal which is fed not only to a regulator to signal for an increase in the supply air temperature, but also to the controller 200 that reads this as a signal to vary the room pressure. In a heating condition, this would likely send $P_{ZU\ MAX}$ as the selected room pressure to comparator 230, to determine the difference with the actual pressure P_{ZU}, the difference ΔP used to activate the controller 286 for increasing the room pressure.

Fig. 5 also illustrates that both pressure and temperature signals are sent to a regulator 320 which signals the throttle valve 330 for varying the room pressure in response thereto:

FIG.5

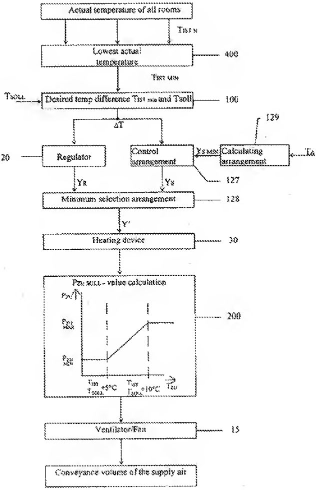


The specification also states: "In the block circuit element 310, the individual desired temperature $\mathbf{T_{SOL\ N}}$ is compared with the corresponding actual temperature $\mathbf{T_{IST\ N}}$; the regulating difference T_N ascertained there is supplied to the regulator 320. On the basis of the temperature difference, $\underline{\Delta}T_N$, of the supply air temperature T_{ZU} and of the

supply air pressure P_{ZU}, this generates a setting signal Y_T which must not fall below a minimal value which is yielded from the actual supply air pressure P_{ZU} and from the minimal pressure $\mathbf{P_{ZU\ MIN}}$. The setting signal $\mathbf{Y_{T\ N}}$ is fed to the throttle control valves 330 in Fig. 5, and 60, 61 in Fig. 1. The regulating controller of this individual temperature regulating circuit is represented by the block circuit element 340. …

The throttle valves 60, 61 are regulated, therefore, in dependence on the desired temperature value $\mathbf{T_{RAUM\ SOLL}}$ in each room individually, on the actual temperature value $\mathbf{T_{RAUM\ IST}}$ measured in each individual room, of the temperature value of the supply air temperature T_{ZU}, as well as in dependence on the supply air pressure P_{ZU} and/or the speed of the supply air motor." (Spec. P. 22, l. 14-P.23, l. 1)

Referring to Fig. 10, the integration of temperature and pressure control is illustrated.



As stated in the specification:

"For a better illustration of the regulating system, in the following there is described, by way of example, a warming-up process such as ordinarily takes place in the morning. The block circuit diagram elements participating in the run-off of the regulation are represented in Fig. 10. At the time point when the switching-on of the air-conditioning apparatus takes place, the actual temperatures of all the rooms 1 and the temperature of the drawn-in fresh air lie far above the desired temperature for the rooms 1. Since the temperature of the supply air is still very low, no more supply air is blown into the rooms. For this, a minimal air pressure $P_{ZU\ MIN}$, corresponding to the minimum of fresh air volume, is generated."(Spec. p. 26, l. 23-p. 27, l. 4)

"From the actual temperatures of all the rooms 1 to be air-conditioned, the minimum-selection controller 400 selects the lowest value and conducts this to the block circuit diagram element 100. Here the regulating difference ΔT between the desired and actual value of the room air temperatures is formed and supplied to the regulator 120 and the controller 127. On the basis of the regulating difference ΔT, the regulator 120 determines a setting value Y_R. Simultaneously with the controller 127, a setting value **YS** is determined, which takes on a maximally great value as long as the desired temperature lies above the actual temperature. Of the two setting values Y_S and Y_R, the selection controller 128 selects the smaller one, at this time point the setting value Y_R of the regulator 120, and conducts it onward to the heating device (30). This warms up the air flowing through the air supply channel (10). Therewith, the air supply temperature T_{ZU} rises continuously. From a predetermined temperature threshold value of the air supply, for example $T_{ZU\ SOLL}$ + 5°C, with further rising air supply temperature, the air supply pressure also is increased, since the regulation of the air supply pressure occurs in dependence on the temperature of the air supply. The conveyance volume increases and there takes place a maximally rapid heating-up of all the rooms." (Spec. P. 27, l. 10-l. 26)

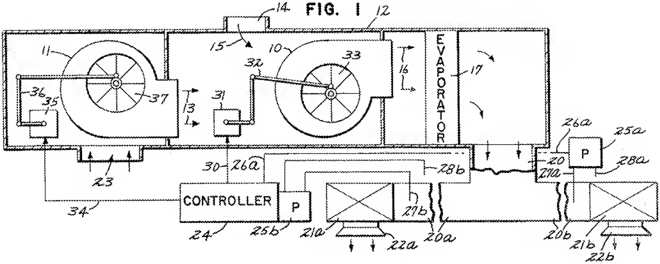
The regulators, controllers, temperature and pressure sensors, valves, motor controls, etc, are structures that may be used to perform the function specified, in various combinations, arranged for utilizing room temperature as a control signal for effecting pressure variations in a room. Various ways of varying the room pressure are discussed in the specification, such as by varying the supply air motor speed, opening or closing a throttle valve to supply more or less air to the room, opening or closing an exit valve, controlling both valves if both are present, or by varying the motor speed of an exhaust air motor, if one is used. Because there are many ways in which to accomplish the stated function, means plus function language is appropriate to use in claim 44.

"Whether a patent adequately sets forth structure corresponding to a claimed function necessitates consideration of the disclosure of the specification from the viewpoint of one skilled in the art. See Budde v. Harley-Davidson, Inc., 250 F.3d 1369, 1376 (Fed. Cir. 2001) (citing 35 U.S.C. § 112, P 1; Am. Cyanamid Co., 7 F.3d at 1579)" Intellectual Prop. Dev., Inc. v. UA-Columbia Cablevision of Westchester, Inc., 336 F.3d 1308, 1319 (Fed. Cir. 2003).

The skill of one in this art is evident from the present application as well as the cited art where a number of these devices are also disclosed for use in various heating and ventilation systems, though not arranged to inter-relate as in the present invention. Such a person would be familiar with temperature and pressure sensors and controllers, valves, motors, etc, and recognize how these are used in the present invention, given the drawings and description as illustrated above.

2(b)The Board requested an explanation of "how such structure differs from the inlet blowers 10, 11, vanes and actuators 33,37,35,31, discharge blower and thermostatically operated damper control boxes 21 a, 21 b disclosed in Johannsen."

The above structure does differs from Johannsen. The question itself identifies the singular difference, specifically as to the "<u>thermostatically operated</u> damper control boxes 21a, 21b of Johannsen". Here is Johannsen Fig. 1, showing the inlet blower 10, which contains vanes for cutting off the flow into the blower, the degree of opening controlled by the actuator 31. The exhaust blower 11 has a similar arrangement, with vanes 37 actuated to open or close off the flow into the blower by actuator 35. Both actuators are responsive to a "controller 24 [which] provides outputs…for controlling the air volume rates of the blowers.". (Col. 5, l. 31-33) Note that this is responsive to pressure only, i.e. transducers 25a and 25b.



A thermostatically operated damper responds only to temperature changes; there is no capacity to increase, decrease or make any change in pressure in response to a desire to vary a room pressure in correspondence to a selected room temperature. The room temperature control is entirely separate from the pressure control scheme: "Damper control boxes 21a and 21b would be thermostatically operated, in the case of an air conditioning system, by separate thermostats in the zones or rooms of the building with which their air discharge is associated, but these temperature control loops are not part of the pressure control system of the present invention, and have therefore been omitted from FIG. 1."(Col. 4, l. 41-47)

Each damper is mounted in a supply duct. Note that there is no return duct leading to the outlet blower 11, thus the ambient/room pressure is the exhaust pressure. This is a common ventilation configuration.

Differential pressure transducers 25a and 25b are used to detect a difference between the supply pressure and ambient next to each damper. When the temperature in the room falls, the thermostatic damper opens to add hot air. What happens then is directly counter to what happens

with the system of the present invention, as the Johanssen invention has as its aim, "….a system for maintaining the pressure within the distribution ducts, as sensed at a plurality of points near a plurality of discharge dampers or outlets, at or above a predetermined minimum pressure for proper air flow and operation of the damper devices, while avoiding excessive pressures which would represent a waste of energy." (Col. 1, l. 9-16)

Regardless of how the individual room dampers operate, the pressure differential between the supply duct and room ambient/exhaust is held constant; the purpose of placing the pressure sensors next to the dampers is to preserve that constant pressure, regardless of how much they may open or close. The system of Johanssen thus prevents any increase in room pressure. Nowhere in Johannsen is there shown or described a controller that is responsive to a temperature signal for generating control signals which would controllably vary room pressure, as illustrated in applicant's Fig. 6A.

A detailed pressure control scheme is shown in Johannsen, but room temperature is not integrated as a control signal for altering room pressure. In fact, with Johanssen's system, it would be impossible…the pressure controller would immediately attempt to counteract any attempt to increase or decrease the room pressure as soon as it was sensed. Consider that the damper opening, or closing would be detected immediately by the adjacent sensors and cause the vanes 33 and 37 to open or close, as needed, to avoid any pressure variation, proven by the fact that the blowers operate with very close tracking over a large volume range, as illustrated in Fig. 5:

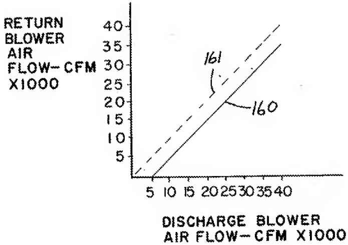


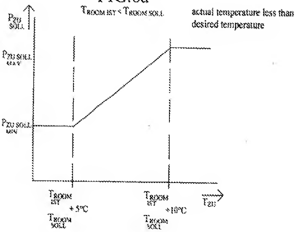
FIG. 5

Whether operating at 5000 CFM or 35,000 CFM, the difference in flow remains the same. This is a static pressure system. There is no structural element in Johannsen that accepts a room temperature signal, for use in varying a room pressure in correspondence thereto. The applicants' system is dynamic, with programmed pressure increases and decreases tracking room temperature variations.

The Board requested information on the use of any "algorithm". No such algorithm is necessary to practice the applicants' invention, as would be well understood by one skilled in the art.

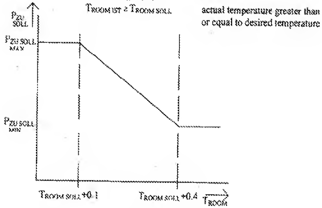
Consider that there are no such algorithms needed to operate an ordinary thermostat, as most temperature control circuits are fairly straight forward …when a low temperature is sensed, an error signal develops that is used by a controller to supply more hot air…when the temperature reaches or exceeds the set/selected temperature, the controller stops supplying the hot air. The same is true with the pressure control, though here, set minimum and maximum

FIG.6a



pressures are determined, and then, when the low temperature is sensed, the controller sets the maximum pressure value as the selected pressure, and there is a corresponding controlled increase in pressure in the room, the pressure being monitored until the maximum set pressure is reached, then, just as with the temperature control circuit, it stops increasing the pressure, and waits for a signal to reduce the room pressure, for example, if the temperature goes too high. This is well illustrated in Figures 6A and 6B, Fig. 6A having a pressure profile when the actual room temperature is less than the desired room temperature, and Fig. 6B having a pressure profile when the actual room temperature is greater than the desired room temperature. (Spec. p. 14, l. 20-26) None of the art cited by the examiner discloses such a pressure regulation system which varies room pressure in correspondence to the selected room temperature.

FIG.6b



As discussed above, Johannsen maintains room pressure regardless of the variations in volumetric flow through the room. In fact, the dead band controller is specifically used to dampen variations so as to closely maintain a constant pressure, regardless of the opening or closing of individual dampers, and to operate independently of the temperature control scheme, as stated on Page 4, lines 45-46. This is contrary to the applicant's invention which has means for regulating the pressure in a room so as to vary the room pressure in correspondence to the selected room temperature, thus the room pressure is a temperature dependant variable.

IV. Conclusion

Claims 44-46 and 51-59 are novel and unobvious, and reversal of each rejection is respectfully requested.

Respectfully submitted,

____/WJS/ _________
William J. Sapone
Registration No. 32,518
Attorney for Applicant(s)

COLEMAN SUDOL SAPONE, P.C.
714 Colorado Avenue
Bridgeport, Connecticut 06605-1601
Telephone No. (203) 366-3560
Facsimile No. (203) 335-6779

EVIDENCE APPENDIX

File History Of U.S. Patent Application no. 10/273,068

APR 2 7 2005

PATENT & TRADEMARK OFFICE

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

or Fax (703) 746-4000

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

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28147 7590 04/18/2005

WILLIAM J. SAPONE
COLEMAN SUDOL SAPONE P.C.
714 COLORADO AVENUE
BRIDGE PORT, CT 06605

04/28/2005 DEMMANU2 00000146 10273068

01 FC:2501 700.00 OP
02 FC:1504 300.00 OP
03 FC:8001 30.00 OP

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Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (703) 746-4000, on the date indicated below.

Kristine C. Bruno (Depositor's name)

[signature] (Signature)

April 25, 2005 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/273,068	10/17/2002	Albert Bauer	582/9-1477A	3467

TITLE OF INVENTION: AIR-CONDITIONING APPARATUS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$1000	07/18/2005

EXAMINER	ART UNIT	CLASS-SUBCLASS
WALBERG, TERESA J	3753	165-246000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 William J. Sapone
2 Coleman Sudol
3 Sapone PC

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

☒ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☒ Advance Order - # of Copies 10

4b. Payment of Fee(s):

☒ A check in the amount of the fee(s) is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☒ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number 040838 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature [signature]

Date April 25, 2005

Typed or printed name William J. Sapone

Registration No. 32,518

APR 27 2005

CERTIFICATE OF MAILING

I hereby certify that this paper and every paper referred to therein as being enclosed is being deposited with the U.S. Postal Service as first class mail, postage prepaid, in an envelope addressed to : Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on April 25, 2005 (Date of Deposit)

By: ________ Date: April 25, 2005
Kristine C. Bruno

Docket No.: 582/9-1477A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Albert BAUER	Conf. No.:3467
Serial No.:	10/273,068	Art Unit: 3743
Filed:	October 17,2002	Examiner: Teresa J. Walberg
For:	AIR CONDITIONING APPARATUS	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUBMISSION OF FORMAL DRAWINGS

Sir:

Enclosed please find the formal drawings figures 1-10 in the above identified application.

Respectfully submitted,

William J. Sapone
Registration No. 32,518
Attorney for Applicant(s)

Coleman Sudol Sapone P.C.
714 Colorado Avenue
Bridgeport, CT 06605
Telephone No. (203) 366-3560
Facsimile No. (203) 335-6779

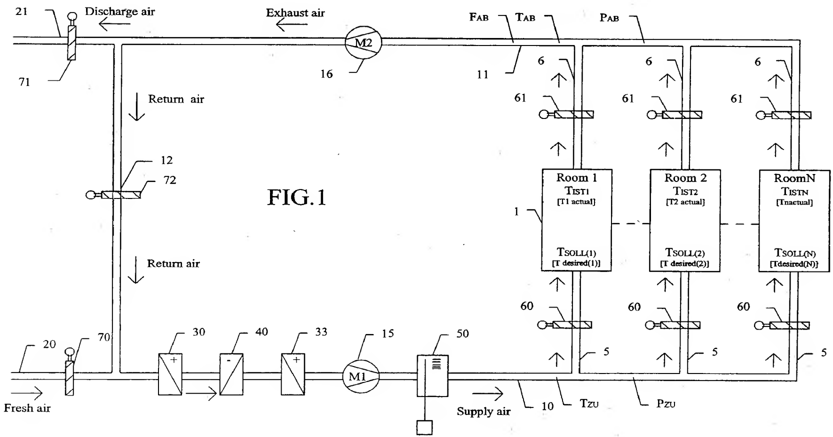

Discharge air
Exhaust air
Return air
Return air
Fresh air
Supply air
M1
M2
Room 1
T_{IST1}
[T1 actual]
$T_{SOLL(1)}$
[T desired(1)]
Room 2
T_{IST2}
[T2 actual]
$T_{SOLL(2)}$
[T desired(2)]
RoomN
T_{ISTN}
[Tnactual]
$T_{SOLL(N)}$
[Tdesired(N)]
F_{AB}
T_{AB}
P_{AB}
T_{ZU}
P_{ZU}
21
71
16
11
6
61
12
72
1
60
5
20
70
30
40
33
15
50
10

FIG.1

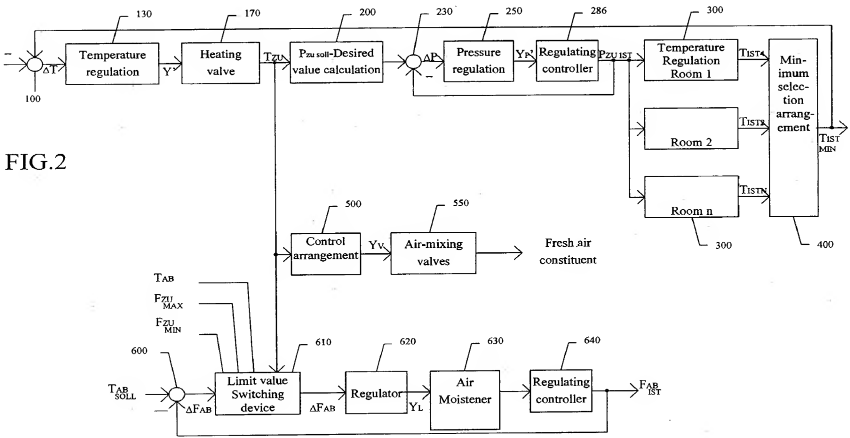

130
Temperature regulation
170
Heating valve
200
Pzu soll-Desired value calculation
230
250
Pressure regulation
286
Regulating controller
300
Temperature Regulation Room 1
Room 2
Room n
300
Min-imum selec-tion arrang-ement
400
ΔT
Y'
TZU
ΔP
YP'
PZU IST
TIST1
TIST2
TISTN
TIST MIN
100
500
Control arrangement
YV
550
Air-mixing valves
Fresh air constituent
TAB
FZU MAX
FZU MIN
600
TAB SOLL
ΔFAB
610
Limit value Switching device
ΔFAB
620
Regulator
YL
630
Air Moistener
640
Regulating controller
FAB IST

FIG.2

FIG.3

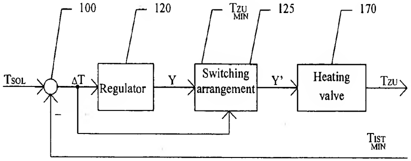


FIG.4

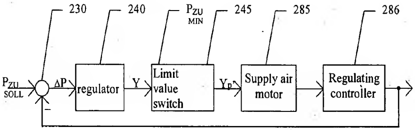


FIG.5

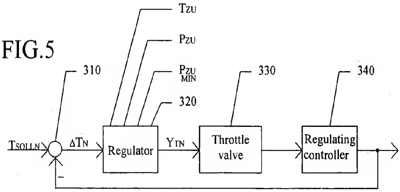


FIG.6a

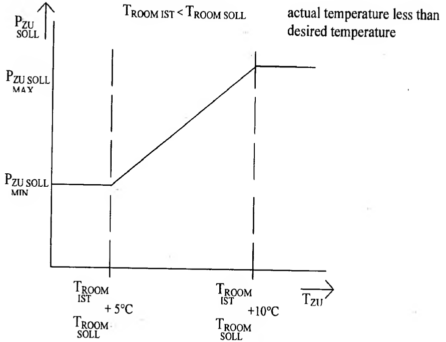

$T_{ROOM\ IST} < T_{ROOM\ SOLL}$
actual temperature less than desired temperature
$P_{ZU\ SOLL}$
$P_{ZU\ SOLL\ MAX}$
$P_{ZU\ SOLL\ MIN}$
$T_{ROOM\ IST}$ + 5°C $T_{ROOM\ SOLL}$
$T_{ROOM\ IST}$ +10°C $T_{ROOM\ SOLL}$
T_{ZU}

FIG.6b

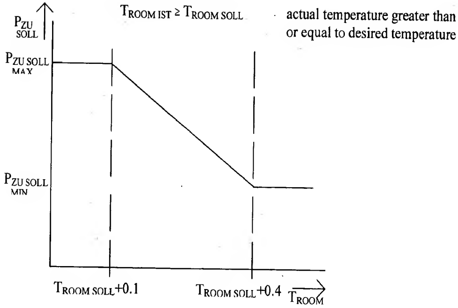

$T_{ROOM\ IST} \geq T_{ROOM\ SOLL}$
actual temperature greater than or equal to desired temperature
$P_{ZU\ SOLL}$
$P_{ZU\ SOLL\ MAX}$
$P_{ZU\ SOLL\ MIN}$
$T_{ROOM\ SOLL}$+0.1
$T_{ROOM\ SOLL}$+0.4
T_{ROOM}

FIG.7

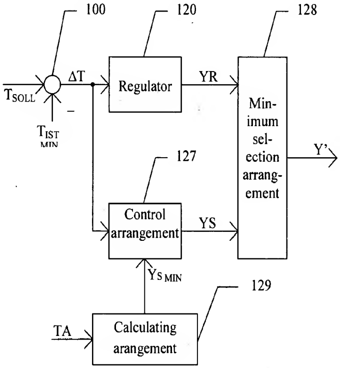

100
120
128
ΔT
Regulator
YR
TSOLL
TIST MIN
Min-
imum
sel-
ection
arrang-
ement
Y'
127
Control
arrangement
YS
YS MIN
129
TA
Calculating
arangement

FIG.8a

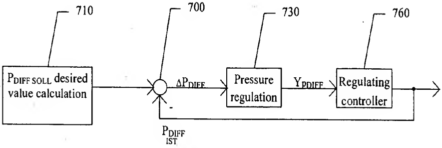


FIG.8b

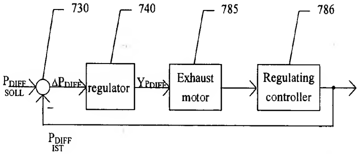


FIG.8c

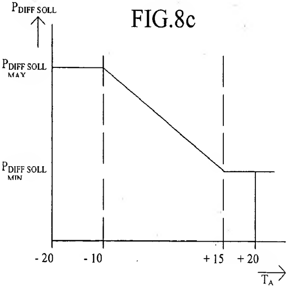


FIG.9

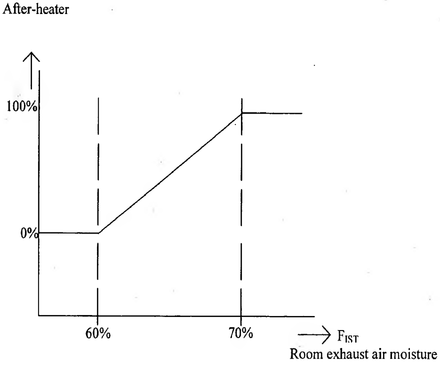
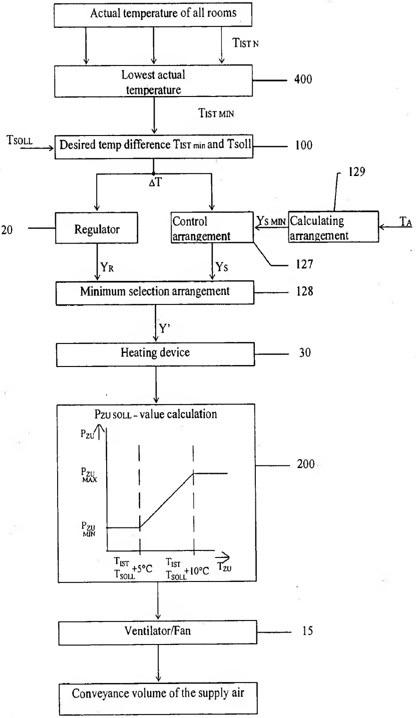


FIG.10


Actual temperature of all rooms
TIST N
Lowest actual temperature
400
TIST MIN
TSOLL
Desired temp difference TIST min and Tsoll
100
ΔT
129
120
Regulator
Control arrangement
YS MIN
Calculating arrangement
TA
127
YR
YS
Minimum selection arrangement
128
Y'
Heating device
30
PZU SOLL - value calculation
PZU
PZU MAX
PZU MIN
TIST TSOLL +5°C
TIST TSOLL +10°C
TZU
200
Ventilator/Fan
15
Conveyance volume of the supply air

10-18-02

PTO/SB/05 (03-01)
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10/17/02 132 U.S. PTO

10/273068 10/17/02 U.S. PTO

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	582/9-1477A
First Inventor	Albert BAUER
Title	Air Conditioning Apparatus
Express Mail Label No.	EL890538716

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [✔] Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing)
2. [✔] Applicant claims small entity status. See 37 CFR 1.27.
3. [✔] Specification [Total Pages 21] (preferred arrangement set forth below)
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [✔] Drawing(s) (35 U.S.C. 113) [Total Sheets 8]
5. Oath or Declaration [Total Pages 2]
   a. [ ] Newly executed (original or copy)
   b. [✔] Copy from a prior application (37 CFR 1.63 (d)) (for continuation/divisional with Box 18 completed)
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [ ] Application Data Sheet. See 37 CFR 1.76
7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies), or
      ii. [ ] paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [ ] Assignment Papers (cover sheet & document(s))
10. [ ] 37 CFR 3.73(b) Statement (when there is an assignee) [✔] Power of Attorney
11. [ ] English Translation Document (if applicable)
12. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
13. [✔] Preliminary Amendment
14. [✔] Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
15. [ ] Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. [ ] Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. [✔] Other: Rule 1.132 Decl Substitute Specification

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

[✔] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: 08 / 998,507

Prior application information Examiner John Ford Group Art Unit 3743

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

19. CORRESPONDENCE ADDRESS

[✔] Customer Number or Bar Code Label (Insert Customer No. or Attach bar code label here) or [ ] Correspondence address below

28147
PATENT TRADEMARK OFFICE

Name					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

Name (Print/Type)	William J. Sapone	Registration No. (Attorney/Agent)	32518
Signature	[signature]	Date	10-17-02

Fee Transmittal Form

Docket No.:	582/9-1477A
Inventor(s):	Albert BAUER
Title:	AIR CONDITIONING APPARATUS

THE FILING FEE HAS BEEN CALCULATED AS SHOWN BELOW:

	Claims filed		Extra	SMALL $ 370.00	LARGE $ 740. 00	**AMOUNT $ 370.00**
Total Claims	**14**	Minus 20	1	x $ 9.00	x $ 18.00	$
Independent	**1**	Minus 03	1	x $42.00	x $ 84.00	**$**
Multiple dependent claim fee				+ $ 140. 00	+ $ 280. 00	**$**
( ) Non-English specification 37 C.F.R. 1.17(k) fee (+ $130.00)						**$**
ASSIGNMENT						**$**
FEE DUE:						**$ 370.00**

[x] A check in the amount of **$370.00** is enclosed.
The Commissioner is hereby authorized to charge any additional fees required with this submission or to credit any overpayment to Deposit Account No. 04-0838.

a. ☒ Fees required under 37 C.F.R. 1.16.
b. ☒ Fees required under 37 C.F.R. 1.17.
c. ☐ Fees required under 37 C.F.R. 118.

Respectfully submitted,
Coleman Sudol Sapone P.C.

By: [signature]
William J. Sapone - Reg. No. 32,518
Attorney for Applicant(s)

October 17, 2002
714 Colorado Ave.
Bridgeport CT 06605
Tel. (203) 366-3560

EXPRESS MAIL No.: **EL890538716US**
Deposited: **October 17, 2002**
I hereby certify that this correspondence is being deposited with the United States Postal Service Express mail under 37 CFR 1.10 on the date indicated above and is addressed to: Commissioner for Patents, Washington, DC 20231

By: Judith Muzyk Date: October 17, 2002
Judith Muzyk

Docket No. 582/9-1477A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Albert BAUER

Serial No.: To bc assigned, Continuation of 08/998,507 Group Art Unit: 3743

Filed : Even date herewith Examiner: John Ford

For : AIR CONDITIONING APPARATUS

Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Prior to the examination of the above referenced application, please amend the above referenced application as follows:

IN THE SPECIFICATION

Please enter the substitute specification enclosed herewith.

On Page 1, under the title, insert: Cross Reference to Related Application.

This application is a continuation of Application Serial No. 08/998,507, now pending.

IN THE CLAIMS:

Please cancel claims 1-31 without prejudice, add new claims 32- 45 as follows:

Claim 32 (New) An air-conditioning apparatus for controlling a temperature condition in at least one room to achieve a selected room temperature condition by ventilation using temperature adjusted supply air comprising:

a supply air motor for supplying air at a supply air pressure through a supply air channel to the at least one room;

cooling-heating means for adjusting a temperature of the supply air;

means for regulating the temperature of the supply air as a function of the difference between the room temperature and the selected room temperature;

means for regulating a pressure in the at least one room, the pressure being adjustably varied relative to an outside pressure to vary the room pressure in correspondence to the selected room temperature the pressure regulated in the at least one room as a function of the supply air temperature.

Claim 33 (New) The air-conditioning apparatus of claim 32 further comprising a control arrangement for controlling the cooling-heating means to adjust the temperature of the supply air.

Claim 34 (New) The air-conditioning apparatus of claim 32 wherein the pressure regulating means further regulates the room pressure relative to an outside air temperature.

Claim 35 (New) The air-conditioning apparatus of claim 32 wherein the pressure regulating means regulates the room pressure by adjusting the supply air motor to alter the supply air pressure.

Claim 36 (New) The air-conditioning apparatus of claim 32 further comprising a control valve disposed in the supply air channel and wherein the pressure regulating means regulates the room pressure by adjusting the control valve.

Claim 37 (New) The air-conditioning apparatus of claim 32 wherein the pressure regulating means regulates room pressure by setting the supply air motor to supply a selected supply air pressure.

Claim 38 (Ncw) The air-conditioning apparatus of Claim 32 further comprising an exhaust air motor to withdraw air from the at least one room through an exhaust air channel.

Claim 39 (New) The air-conditioning apparatus of Claim 38 further comprising means for regulating an amount of exhaust air withdrawn from the at least one room.

Claim 40 (New) The air-conditioning apparatus of claim 38 wherein the pressure regulating mcans rcgulates the room pressure by setting the supply air motor to supply a set increased selected supply air pressure and by setting the exhaust air motor to withdraw a selected amount of exhaust air from the at least one room.

Claim 41 (New) The air-conditioning apparatus of Claim 38 wherein thc prcssurc regulating means regulates the room pressure by adjusting the exhaust air motor, to adjust an amount of air withdrawn from the room through the exhaust air channel.

Claim 42 (New) The air-conditioning apparatus of Claim 39 wherein the pressure regulating means adjusts the room pressure by adjusting the exhaust air regulating means to control the amount of exhaust air withdrawn from the room.

Claim 43 (New) The air-conditioning apparatus of Claim 38 wherein the room pressure is a measurcd difference between a value of the supply air pressure and a value of an exhaust air pressure.

Claim 44 (New) The air-conditioning apparatus of Claim 32 wherein the pressure regulating means effects a change in room pressure only when an outside temperature changes within a predetermined temperature range, and when the outside temperature is lower than the predetermined temperaturc range, the pressure regulating means effects a

room pressure having a first constant value, and when the outside temperature is higher than the predetermined temperature range, the regulating means effects a room pressure having a second constant value.

Claim 45 (New) The air-conditioning apparatus of Claim 44 wherein the pressure regulating means decreases the room pressure from a selected maximum room pressure to a selected minimum room pressure relative to an increase of the outside temperature within the predetermined temperature range.

REMARKS

Favorable consideration and allowance of the application is respectfully requested. Claims 1-31 were in the original application, claims 1-31 have been canceled without prejudice and new claims 32-45 have been added.

The substitute specification as filed in the parent case has been refiled in this continuation.

The applicant, Mr. Bauer wishes to thank the examiner for allowing the interview, and for assisting in proposing possible modifications to the claims to clarify the invention.

New claim 32 is similar to claim 44 in the parent application, but amended to add the temperature regulating means as discussed, as well as the relationship of the supply air temperature to the controlled room pressure. Support for this relationship is found in the specification, Page 5, lines 5-10 and Page 7, lines 4-6.

Claim 37 was additionally amended to change from a "set increase" supply air pressure, to a "selected" supply air pressure, to clarify that the pressure may increase or decrease, as confirmed by Mr. Bauer, over a range of values, as shown in Figs. 6a, 6b and 8c. Claim 40 was similarly amended.

As discussed at the interview, the prior art describes various systems for maintaining a constant room pressure, even when there is variable volume flow through a room. There is no room pressure regulation which controllably adjusts room pressure relative to a selected room temperature as a function of the supply air temperature.

The applicants' invention utilizes an interrelationship between room temperature and room pressure such that the differential pressure in a room will vary in response to various parameters, as shown for example in Figs. 6a and 6b.

Enclosed herewith is a Declaration by Mr. Bauer further describing his invention. It was discovered by Mr. Bauer that utilizing pressure control together with temperature control offered significant benefits in terms of air mixing and energy costs, which would be and indeed have been considered quite surprising to those skilled in the art. Typically, the prior art teaches increasing flow through a room to effect a temperature change, with no pressure regulation, resulting in high energy costs, drafts, and little air mixing. The consequence is a high recycle rate of stale air, blended with a minimal amount of fresh air. This of course has numerous disadvantages. The Bauer system in accordance with claim 32 avoids the high recycle rate, and can provide 100 % fresh air make-up, with superior air mixing and a dramatic improvement in comfort. This was visually confirmed in the videotape showing testing in several different buildings.

The rejection in the parent case for anticipation by Johannsen, U.S. 4,257,318, is believed to be moot in view of the above discussion, as Johannsen lacks a pressure regulation means as required by claim 32.

The present claims are also not obvious over Johannsen in view of Rayburn, et al U.S. 5,971,067. There is no teaching or suggestion in either patent for active regulation of room pressure in relation to adjustments to room temperature and as a function of supply air

temperature, resulting in improved air mixing and reduced energy costs. In fact, the opposite is true as both cited patents describe systems that maintain a room temperature, though volumetric flow may vary. As there is no teaching or suggestion for providing a system according to the applicants' invention, claims 32-45 are believed patentable over the art cited.

Based on the above amendments and remarks, favorable consideration and allowance of the application is respectfully requested.

Respectfully submitted,

William J. Sapone
Registration No. 32,518
Attorney for Applicant(s)

COLEMAN SUDOL SAPONE, P.C.
714 Colorado Avenue
Bridgeport, Connecticut 06605-1601
Telephone No. (203) 366-3560
Facsimile No. (203) 335-6779

NEW CLAIMS

32. An air-conditioning apparatus for controlling a temperature condition in at least one room to achicve a selected room temperature condition by ventilation using temperature adjusted supply air comprising:

a supply air motor for supplying air at a supply air pressure through a supply air channel to the at least one room;

cooling-heating means for adjusting a temperature of the supply air;

mcans for regulating the temperature of the supply air as a function of the difference between the room temperature and the selected room temperature;

means for regulating an increase in a pressure in the at least one room, the prcssure being adjustably varied relative to an outside pressure to vary the room pressure in correspondence to the selected room tcmperature the pressure regulated in the at least one room as a function of the supply air temperature.

33. The air-conditioning apparatus of claim 32 further comprising a control arrangement for controlling the cooling-heating means to adjust the temperature of thc supply air.

34. The air-conditioning apparatus of claim 32 wherein the pressure regulating means further regulates the room pressure relative to an outside air temperature.

35. The air-conditioning apparatus of claim 32 wherein the pressure regulating means regulates the room pressure by adjusting the supply air motor to alter the supply air pressure.

36. The air-conditioning apparatus of claim 32 further comprising a control valve disposed in the supply air channel and wherein the pressure regulating means regulates the room pressure by adjusting the control valve.

37. The air-conditioning apparatus of claim 32 wherein the pressure regulating means regulates room pressure by setting the supply air motor to supply a set increased selected supply air pressure.

38. The air-conditioning apparatus of Claim 32 further comprising an exhaust air motor to withdraw air from the at least one room through an exhaust air channel.

39. The air-conditioning apparatus of Claim 38 further comprising means for regulating exhaust air motor to adjust an amount of exhaust air withdrawn from the at least one room.

40. The air-conditioning apparatus of claim 38 wherein the pressure regulating means regulates the room pressure by setting the supply air motor to supply a set increased selected supply air pressure and by setting the exhaust air motor to withdraw a set selected amount of exhaust air from the at least one room.

41. The air-conditioning apparatus of Claim 38 wherein the pressure regulating means regulates the room pressure by adjusting the exhaust air motor, to adjust an amount of air withdrawn from the room through the exhaust air channel.

42. The air-conditioning apparatus of Claim 39 wherein the pressure regulating means adjusts the room pressure by adjusting the exhaust air regulating means to control the amount of exhaust air withdrawn from the room.

43. The air-conditioning apparatus of Claim 38 wherein the room pressure is a measured difference between a value of the supply air pressure and a value of an exhaust air pressure.

44. The air-conditioning apparatus of Claim 32 wherein the pressure regulating means effects a change in room pressure only when an outside temperature changes within a predetermined temperature range, and when the outside temperature is lower than the

predetermined temperature range, the pressure regulating means effects a room pressurc having a first constant value, and when the outside temperature is higher than thc predetermined temperature range, the regulating means effects a room prcssure having a second constant value.

45. The air-conditioning apparatus of Claim 44 wherein the pressure regulating means decreases the room pressure from a selected maximum room pressure to a selected minimum room pressure relative to an increase of the outside temperature within the predetermined temperature range.

AIR-CONDITIONING APPARATUS

desired

FIELD OF INVENTION

The invention relates to an air-conditioning apparatus which regulates the temperature in at least one room by ventilation with heated or cooled air to a predetermined temperature desired value.

BACKGROUND OF THE INVENTION

Air-conditioning apparatuses are used to create in the air-conditioned rooms comfortable conditions of occupation at any time of year, as they hold the temperature and humidity of the room air within fixed limits and provide for a sufficient ventilation with fresh air.

In winter the supply air temperature is higher than the room air temperature when the air is also meant to warm the room, and in summer the supply air is injected at a lower temperature in order to hold the room at the desired cooled room air temperature.

This AS

Ordinarily, to achieve this, a conventional air-conditioning apparatus circulates too high an amount of air, the temperature of which has been adapted to the heating and cooling requirement. There, it is regarded as disadvantageous that a large volume of air is circulated even after the desired temperature has already been reached. Moreover, the danger exists that the supply air will be blown into the room over the supply air channel and will immediately leave the room to be air-conditioned over the exhaust air channel. There takes place a very small mixing of the new supply air with the air present in the room.

Little Through

Used

Further, in the air-conditioning of several rooms, there is the problem that different desired temperatures are present in the rooms. An adaptation of the temperatures which takes into consideration the comfort in each room is possible only with difficulty.

Sought

SUMMARY OF THE INVENTION

providing

Underlying the present invention is the problem of giving an air-conditioning apparatus which operates economically, ensures more comfortable room conditions and an optimal mixing of the room air with the supply air, in order to achieve a rapid adaptation to the heating, cooling, humidifying and dehumidifying desired values.

desired desired An

This problem is solved according to the invention by the means that the air-conditioning apparatus which regulates the temperature in at least one room to a predetermined temperature desired value by ventilation with heated or cooled air. The apparatus is provided with a supply air motor which feeds the supply air over a supply air channel to the room to be air-conditioned, with a cooling and/or heating device introduced into the supply air channel for the cooling or warming of the supply air, and with an exhaust

Through

Through

air motor which draws the exhaust air [over] an exhaust channel out of the room to be air-conditioned, in which the desired value for the regulator of the exhaust air motor builds up a room excess pressure established with respect to the outside pressure. Further advantageous embodiments of the invention form the objects of the subclaims.

Underlying the invention is the perception that the greater the excess pressure is in a room to be air-conditioned, the better is the ventilation by the supply air blown through the room. Therewith, the room warms up faster, the efficiency of the installation is improved and great temperature fluctuations in the room are avoidable for example, very warm at the top and very cool at the bottom, as are also temperature differences over the length and width of the room.

Because of

A good flow of air through the room ensures that in the shortest possible time and with a smaller amount of air, a room is heated, cooled, humidified or dehumidified. The smaller amount of supply air blown in is found pleasant. [For] the faster adaptation [of] the heating, cooling, humidifying and dehumidifying [desired] values, the efficiency of the air-conditioning apparatus is improved. To desire

In particular, the desired value for the regulator of the exhaust air motor is determined in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure. This regulating of the exhaust air motor, in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure, is important for the optimization of the air flow. The higher the supply air temperature or the supply air pressure is, the greater the excess pressure would have to be for a favorable flow of air through the room to be air-conditioned with the supply air. The lower, however, the outside temperature is, the higher as a rule, therefore, the excess pressure in the room to be air-conditioned has to be. There must, therefore, be present a greater excess pressure for [the] ensuring [of] an optimal flow of air through the room with the blown-in supply air.

A

On the one hand, preferably the actual value for the regulator of the exhaust air motor is determined by pressure difference [the] between the channels, which is calculated from the difference between the absolute value of the pressure in the supply air channel and the absolute value of the pressure in the exhaust air channel. It will then be the case that, for example, excess pressure disturbances will occur in the air-conditioning apparatus in several rooms as a result of opening of windows in individual rooms, and [therewith] this results in An undesired rise of the excess pressure in the other rooms, taking place through the regulation of the exhaust air motor, by reason of the pressure loss in one room. Therefore

On the other hand, preferably the actual value for the regulator of the exhaust air motor is formed by the room pressure difference which is calculated from the difference between the outside pressure and the room pressure.

Here above all, the room excess pressure varies exclusively over a predetermined temperature range of the outside temperature and/or of the supply air temperature, with A change of the outside temperature or of the supply air temperature, in which with an outside

Below   Above

temperature before this temperature range, the room excess pressure has in each case a certain constant value and with an outside temperature or supply air temperature after this temperature range, the room excess pressure always has a further definite constant value. Above all, with rising outside temperature, in that temperature range, the room pressure falls from a maximum excess pressure to a minimal excess pressure.

Thereby account is taken of two opposite demands. On the one hand, for a good flow of air through the room to be air- conditioned, it is required that the excess pressure be as high as possible. On the other hand, the excess pressure must not be too great, because it is otherwise felt to be disagreeable, and with too great excess pressure, doors open themselves or no longer open ean be opened or closed only with high expenditure of force.
ARE

So that a comfortable regulation will be accomplished and an excess pressure will be ensured independently from the height or the floor level of the room to be air-conditioned, the room difference pressure is measured at a height or level over 0 (room height). Room height corresponds to outside elevation in respect to sea level.

VALUE   VALUE   A

According to one embodiment of the invention, the temperature of the supply air and the channel pressure of the supply air are coupled with one another in such manner that both, in dependence on the height of the room temperature to the height of the supply air temperature and also in dependence on the height of the room temperature to the height of the desired value of the room temperature, the channel pressure of the supply air is raised or lowered in the room, rooms or room zones.
VAlue

The advantages herewith achieved lie especially in that a great volume of air-conditioned air is not unnecessarily circulated, but always only that volume that is required for a maximally rapid adaptation of the actual room values to the predetermined desired values.

In this manner not only are savings in energy achieved, but people in the room find it considerably more agreeable when a relatively strong air movement takes place only when the temperature of the blown-in air deviates from the actual temperature. With conventional air-conditioning apparatuses, in contrast, especially during the morning warming-up phase, even at a room temperature that lies far below the desired value, only slightly warmed supply air is blown into the rooms at a high channel pressure. This was hitherto felt to be disagreeable by the persons concerned, but it was regarded as unavoidable.

According to the present embodiment of the invention, heated air with the higher channel pressure is blown into the room only if the temperature of the supply air lies clearly above the predetermined desired temperature of the room and therewith, in the warming-up phase lies far above the actual value of the room. By a relation regulation in which the channel pressure of the supply air is set in a fixed relation to the supply air temperature, a corresponding coupling of channel pressure of the supply air pressure to the supply air temperature can be realized especially advantageously.

Preferably the channel pressure of the supply air into the room, the rooms, or the room zones is adjusted over the [line] of the supply air motor.

RANGE

For a selecting arrangement, a choice can be made between two delivery volume relations.

In the first place, for the heating case in which the desired value of the room temperature is less than the actual value of the room temperature, the channel pressure of the supply air is lowered with rising room temperature. Correspondingly, for the cooling case in which the desired value of the room temperature is greater than the actual value of the room temperature, the channel pressure of the supply air is lowered with falling room temperature. In the second place, for the heating case in which the desired value or the actual value of the room temperature is less than the supply air temperature and the actual value of the room temperature is less than the desired value of the room temperature, the channel pressure of the supply air is raised with rising supply air temperature. Correspondingly, for the cooling case in which the desired value or actual value of the room temperature is greater than the supply air temperature and the actual value of the room temperature is greater than the desired value of the room temperature, the channel pressure is raised with falling supply air temperature. The increase of the channel pressure of the supply air is found to be pleasant. Moreover, the efficiency of the heating and cooling apparatus is improved, as will be stated again further below.

VALUE BELOW

According to a further embodiment of the invention, the channel pressure of the supply air varies exclusively over a predetermined temperature range of the supply air temperature. If the supply air temperature presents a [height] [before] this temperature range, then the channel pressure of the supply air is allocated in each case to a certain constant magnitude. If the supply air temperature presents a [height after] the temperature range, then the channel pressure of the supply air is allocated in each case to a further determined constant magnitude.

VALUE ABOVE

In particular, with a supply air temperature higher with respect to the room temperature, the channel pressure rises over the predetermined temperature range of the channel pressure from its minimum performance up to its maximum performance with rising supply air temperature, and it correspondingly falls with falling supply air temperature.

Through the two regulating systems of the supply air channel pressure behavior, on the one hand, it is made possible for the efficiency of the air-conditioning apparatus to be improved. With higher channel pressure of the supply air, there is achieved also a more rapid and better flow through the room, and therewith a faster heating up of the rooms. On the other hand, for reasons of comfort, too great an air flow should be avoided, since this is felt to be disagreeable. The opposite demands are now optimally satisfied.

Here the regulating circuit which regulates the channel pressure of the supply air is subordinated to the temperature regulating circuit; the desired supply channel pressure value being set in a fixed relation to the actual value of the supply air temperature. Herewith there

is avoided any excessive increasing or decreasing in the temperature regulation. The room temperature swings back faster to the desired [value] temperature.

Value Through

With air-conditioning for several rooms, the heated supply air is made available [over] a common supply air channel. In the case of different desired and actual temperatures of all the rooms, however, each room has a different heating requirement. In order to take this circumstance into account, according to a further form of execution of the invention, in the simultaneous air-conditioning of several rooms or room zones, the individual rooms or room zones are connected in each case [over] a supply air, and an exhaust air line allocated to them [to] the central supply air and exhaust air channels, and in the individual supply air and/or exhaust air lines, throttle [clack] valves are arranged [over] which the channel pressure of the supply air is adjusted in the room, the rooms or room zones.

From Through

Thereby undesired air movements are avoided in rooms, the actual and desired values of which are alike or approximately alike. Moreover it is achieved that, for example, in the case of a fully open fresh air [clack] valve, an excessive amount of fresh air is not worked up.

Control

The regulation of the [clack] valves can occur additionally in dependence on supply air pressure or on the [turning rate] of the supply air motor.

Speed

In such an independent regulation of supply air temperature and individual room temperature, a situation can arise in which a single room has to be heated as rapidly as possible, but other rooms that already lie at their desired temperature are to be heated up as little as possible. When the supply air temperature rises, the individual regulation of these warm rooms will tend to close the [clack] valves. Therewith, however, these rooms and the persons present in them are cut off from the fresh air supply.

Control

This problem is advantageously solved according to a further embodiment, in which at a supply air temperature that lies above the desired temperature, in rooms the actual temperature of which corresponds to the desired temperature, the requisite minimum volume of fresh air also is blown. In this manner it is achieved that these rooms are supplied with sufficient fresh air; nevertheless, a possible warming of the rooms by reason of a supply air temperature that lies above the desired temperature is avoided insofar as possible. The minimal opening required for the prescribed minimum fresh air volume depends on the supply air temperature and on the fresh air component of the supply air, for the fresh air component of the supply air is reduced, if possible, warming-up phase in the morning for a maximally rapid heating up [and] replaced by return air.

during the

Through a Being

According to one embodiment, the exhaust air channel and the supply air channel are connected with one another [over] a return air channel, in which case at least one air exhaust throttle [clack] valve is provided in the return air channel, and at least one fresh air throttle [clack] valve is provided in the fresh air channel engaged ahead of the supply air channel.

Control Control

According to a further embodiment, the minimum cross section of the throttle [clack] valves is adjusted in dependence on the opening of the fresh air throttle [clack] valve, of the

Control

Control Control

exhaust air throttle clack valve and of the mixing air throttle clack valve, so that in each regulation situation there is ensured the minimum amount of fresh air.

With regulated channel pressure for the supply air and for the exhaust air, the opening positions of the throttle clack valves allocated relative to one another in a room or in a room zone are equal.

Control

Analogously to the heating regulation, there can also take place a cooling regulation.

For the temperature regulation, regulators are used. In practice, these regulators tend to an overswinging and underswinging of the regulating magnitude.

Value

According to a further embodiment of the invention, in each case the setting value of at least one regulator, especially of the temperature regulator, is connected to a subordinated switching arrangement, and the switching arrangement, in the case of an overswinging (exceeding) of the regulating magnitude, selects a value predetermined for it, as the setting magnitude which clearly lies under the value chosen simultaneously by the regulator.

Value Value Value

Such a behavior can advantageously be obtained by an additional control arrangement and a minimum-selection arrangement. This additional control arrangement delivers, in dependence on the regulating difference, a predetermined minimal value for the setting magnitude when an overswinging of the regulating magnitude occurs, and a predetermined maximal value for the setting magnitude when the actual value of the temperature (the regulating magnitude) lies below the desired value. The minimum selection arrangement then in each case selects the minimum, from the values made available by the regulator and the additional control arrangement, and forwards the selected value as setting magnitude. In this manner the additional control arrangements always takes over the control of the setting magnitude when by reason of the setting magnitude of the regulator an overswinging (exceeding) occurs in the regulating magnitude.

Value Value The Value

An

According to a further embodiment of the invention there are provided a fresh air clack valve in a fresh air channel engaged on inlet side of the supply air channel, a mixed air clack valve in a return air channel connecting the supply air channel with the exhaust air channel, and a discharge air clack valve in a discharge air channel connecting to the exhaust air channel, in which situation the settings of the fresh air clack valve, of the discharge air clack valve and of the mixed air clack valve are regulated in common dependence on the turning rate of the supply air motor or on the channel pressure of the supply air, and in which up to a certain minimal opening for the ensuring of a fresh air minimum, with increasing turning rate of the supply air motor and/or with rising channel pressure of the supply air, the opening cross sections of the fresh air clack valve and of the discharge air clack valve can be reduced and the opening cross section of the mixed air clack valve can be increased.

Control

Speed

Control

The opening position of the fresh air clack valve and the opening position of the exhaust air clack valve are always of equal size. The opening position of the mixed air clack valve is always the difference of the opening position or the fresh air or exhaust air clack

Of Control

control

valve to 100%, for example, if the opening positions of the fresh air [clack] valve and exhaust air throttle [clack] valve are each case 70%, then the opening position of the mixed air [clack] valve is 30%. If the mixed air [clack] valve has an opening position of 70%, then the opening positions of the fresh air and exhaust air [clack] valves are in each case 30%.

Through

In a further preferred embodiment of the invention, more than one room is air-conditioned from a central installation. In the case of different heating requirements for the individual rooms, it is also necessary to make available [over] the supply air a sufficient heating capacity for all the rooms. This can be achieved inter alia by the means that the heating required is measured in accordance to the actual temperature of the coldest room, in order to bring also this room to the desired temperature in a short time. Accordingly, in one form of execution of the invention, in the simultaneous air-conditioning of several rooms, the actual temperature of each room is fed to a central regulating arrangement, and a temperature value to be determined individually from these individual actual values is supplied as actual value for the heating regulator.

An humidifying

According to a further embodiment of the invention, a [moistening] arrangement is provided which humidifies the supply air in the supply air channel, in which process the humidifying arrangement is regulated both in dependence on the room moisture or the exhaust air moisture as well in dependence on the supply air temperature.

According to a further embodiment of the invention, there are provided a first heating device installed in the supply air channel, a cooling device engaged after the first heating device in the supply air channel, and a second heating device installed after the cooling device in the supply air channel for the heating, cooling and dehumidifying of the supply air, the second heating device being regulated for the desired [value] moisture in dependence on the actual [value] moisture.

value value

In particular with a rising actual value humidity which already lies above the desired [value] humidity, the heating performance of the second heating device rises.

value Below

The heating performance of the second heating device is regulated either with a regulator or it climbs with rising actual value moisture over a predetermined moisture range of the room moisture; at a room moisture content [before] this moisture range, the heating performance has in each case a certain constant magnitude and at a room moisture [after] the moisture range, the heating performance has in each case a further determined constant magnitude. Above

Rising

It is hereby achieved that a dehumidifying is brought about over [raising of the] room temperature[s] insofar as the actual value of the room temperature remains under the limit value from which the cooling process is initiated. Cooling starts only when the actual value of the room temperature is greater than the desired value of the room temperature plus the temperature displacement dependent on the outside temperature. By the heating-up, and therewith the dehumidifying of the room over the rising temperature, the room is dehumidified [rapidly and] with a relatively low expenditure of energy.

RAPIDLY

The channel pressure of the supply air is not raised during the dehumidifying process.

control

In order to guarantee a minimum amount of fresh air in the room or the rooms, the regulation of the fresh air clack valve and of the discharge air clack valve occurs in dependence on the opening position of the mixed air clack valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings, which are included to provide further understanding of the present invention and are incorporated in and constitute a part of this specification, illustrate the preferred embodiments of the invention and together with the description serve to explain the principles of the invention.

In the simplest case, a single room is tempered and ventilated with the air-conditioning apparatus. The regulation of a multi-room air-conditioning is described in the example of execution with the aid of the drawing, in which:

Fig. 1 shows a schematic representation of the air circulation in an air-conditioning apparatus according to the invention.

Fig. 2 is a block circuit diagram with the most important elements of the regulating and control arrangements of the example of execution.

IN All

Fig. 3 is a block circuit diagram with important elements of the temperature regulating circuit from Fig. 2.

Fig. 4 is a block circuit diagram of the conveyance volume regulating circuit of the supply air from Fig. 2.

Fig. 5 is a block circuit diagram of the individual temperature regulating circuit for each room from Fig. 2.

Fig. 6a shows the relation between the supply air temperature and the supply air pressure for the example of execution when the room actual temperature is less than the desired value-room temperature. VALUE

Fig. 6b shows the relation between the room temperature and the supply air pressure for the example of execution when the actual vacuum room temperature is greater than or equal to the desired value room temperature. VALUE

Fig. 7 is a block circuit diagram of the temperature regulator of the example of execution.

Fig. 8a is a block circuit diagram of the regulator of the exhaust air motor of the example of execution.

Fig. 8b is the block circuit diagram with the most important elements from Fig. 8a.

Fig. 8c shows the relation between the desired value of the room difference pressure for the regulator of the exhaust air motor.

Fig. 9 shows the relation between the room exhaust air moisture and the setting [magnitude] for the after-heater.
Value

Fig. 10 is a run-off diagram with the most important block circuit diagram elements participating in the heating-up process.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1 there is schematically represented the air circulation of a multi-room air-conditioning system. From the rooms 1 to be air-conditioned there lead, on the one hand, supply air lines 5 to a supply air channel 10 and, on the other hand, exhaust air lines 6 to an exhaust air channel 11.

Control

In the supply air line 5 there is arranged in each case a throttle [clack] valve 60 and in the exhaust air line 6 in each case a throttle [clack] valve 61.
Control

The supply air channel 10 and the exhaust air channel 11 are connected with one another [over] a return air channel 12.
Through

On inlet side of the supply air channel 10 there is engaged a fresh air channel 20 and on the outlet side of the exhaust air channel 11 there is engaged an exhaust air channel 21.

Control

In the fresh air channel 20 there is provided a fresh air throttle [clack] valve 70, in the return air channel 12 a mixed air throttle [clack] valve 72 and in the exhaust air channel 21 an exhaust air throttle [clack] valve 71.
Control

In the supply air channel 10 there are arranged successively in flow direction of the air a first heating device 30, a cooling device 40, a second heating device 33, a supply air motor 15 and humidifying device 50.
A

In the supply air channel there is generated by the supply air motor 15 an air pressure P_{ZU} which provides that the supply air is blown with sufficient conveyance volume into the rooms 1 to be air-conditioned.

Correspondingly in the exhaust air channel 11 re is generated by the exhaust air motor 16 a subpressure P_{AB}, which draws off the room air.

Taken Through

i.e. In the simplest case, the pure airing case (office operation) the drawn off room air (=the exhaust air) is [given] off [over] the exhaust air channel 11 and the exhaust air channel 21 to the outer atmosphere, and [over] the fresh air channel 20 the required supply air is drawn as fresh air into the supply air channel 10. For this the fresh air throttle [clack] valve

Through Control

AIR CONTROL
70 and the exhaust throttle ~~[air]~~[clack]valve 71 are opened and the mixed air throttle [air][clack] valve 72 is closed. The fresh air throttle [clack] valve 70 and the exhaust air throttle [clack] valve 71, there, always have equal opening settings.

Through
In order to make possible a warming-up of the air-conditioned rooms 1, the drawn-in fresh air flows through the first heating device 30 (preheater) [over] which drawn-in air is brought according to heating requirement to the requisite supply air temperature T_{ZU}. After passing the disengaged cooling device 40 and the second heating device 33 (afterheater) it is fed to the humidifying arrangement 50, which supplies the necessary moisture to the air.

humidifying
Instead of the first heating device 30, in a required cooling of the rooms to be air-conditioned the cooling device 40 is in operation. In the case of excessive humidity, instead of the [moistening] device 50, the afterheater 33 is in operation for the dehumidifying. In order to ensure a more rapid heating-up, both the first heating device 30 and also the second heating device 33 can be in operation. This, however is possible for the heating case, not for the dehumidifying case.

Through
The air worked-up in this way is fed to the individual rooms to be air-conditioned, [over] the supply air motor 15, the supply air channel 10 and the supply air lines 5 with the throttle [clack] valves 60. The volume of the air blown-in and drawn off from each individual room can be regulated by the throttle [clack] valves 60, 61 arranged in the supply air lines 5 and in the exhaust air lines 6 individually. control
control (controller)

In the case of increased heat requirement, for example in the morning warm-up phase, it is advantageous to supply the rooms not only with drawn-in fresh air, but to use a part of the drawn-off room air repeatedly, for in the simultaneous warming-up and ventilation the required supply air volume lies far over the fresh air minimum volume. For this reason, in dependence on the supply air temperature T_{ZU} [over] a control arrangement 500 in Fig. 2, a setting value Yv is calculated and supplied to the air throttle [clack] valves 550 in Fig. 2, or 70, 71, 72 in Fig. 1.

control Through control
While the fresh air throttle [clack] valve 70 and the exhaust air throttle [clack] valve 71 receive the same control signal, the mixed air throttle [clack] valve 72 in the return air channel 12, there, is supplied the exactly opposite control signal. The open position of the mixed air throttle [clack] valve 72 is always the difference between the open position of the fresh air [clack] valve 70 or of the exhaust air [clack] valve 71 and 100%. For example the open position of the fresh air [clack] valve 70 and of the exhaust air [clack] valve 71 amounts in each case to 70%, then the open position of the mixed air [clack] valve 30 amounts to 30%. If the mixed air [clack] valve has an open position of 70%, then the open position of the fresh air [clack] valve 70 and of the exhaust air [clack] valve 71 is in each case 30%.

control Through
Through
In this manner it is possible again to feed a certain proportion of the drawn-off room air [over] the return air channel 12 to the supply air. Simultaneously [over] the fresh air channel 20 and the fresh air clack valve 70, a corresponding fresh air component is supplied to the supply air. This fresh air component amounts in the example of execution in the

control

airing case (during the office hours) to up to 100%. During office hours, therefore, the mixed air clack valve 72 as a rule is not opened, (and) the fresh air clack valve 70 and the exhaust air clack valve 71 are normally opened to 100% each. With increased heating requirement and a maximal supply air pressure $P_{ZU\ MAX}$ the fresh air component falls to approximately 10%—warming-up phase in the morning.

controller

In the air-conditioning, from the measured room temperatures $T_{RAUM\ IST1}$, $T_{RAUM\ IST2}$ or $T_{RAUM\ IST\ N}$ in the minimal selection arrangement 400 in Fig. 2, the lowest value $T_{RAUM\ IST\ MIN}$ is determined and used for the calculation of the heating requirement. For this the actual temperature $T_{RAUM\ IST\ MIN}$ in the block circuit diagram element 100 is subtracted from the predetermined (maximal) desired temperature $T_{RAUM\ SOLL}$ (of all the rooms). On the basis of the temperature difference T (regulating difference), by the temperature regulation 130, there is determined a suitable desired value y' for the heating valve 170 of the heating device 30 in Fig. 1.

switching controller

The setting value Yr calculated in Fig. 3 for the temperature regulation is monitored by the circuited arrangement 125 arranged on outlet side in order largely to prevent an overswinging of the temperature usual with conventional regulators. In the normal case, as long as $T_{RAUM\ IS\ MIN}$ lies below $T_{RAUM\ SOLL}$, the arrangement 125 forwards the setting value Y_R unaltered as y' onward to the heating valve 170. If, however, $T_{RAUM\ IST\ MIN}$ exceeds the desired temperature $T_{RAUM\ SOLL}$ then, instead of Y_R a much smaller setting value y' will be forwarded on to the heating valve 170. The value of the setting magnitude y' assures in this case the minimally required supply air temperature $T_{ZU\ MIN}$, which is dependent on the outside temperature T_A. In this manner with the example of execution, there is achieved a maximal overswinging of the desired temperature by only 0.3 °C; a falling below this virtually does not take place.

controller

The monitoring of the setting signal Y_R of the regulator 120 is executed in the example of execution by a switching arrangement 127 in Fig. 7 and a minimum selection arrangement 128. The control arrangement simultaneously generates for the regulator 120 a setting signal Y_S which takes on a maximally great value as long as the desired temperature $T_{RAUM\ SOLL}$ lies above the actual temperature $T_{RAUM\ IST}$ and down to the very low setting $Y_{S\ MIN}$ as soon as the actual temperature exceeds the desired value. moves

controllers

system ler

The setting value $Y_{S\ MIN}$ of the control arrangement 128 is adjusted by the computing arrangement 129 for the cutting-off of the otherwise occurring underswinging of the temperature regulation in dependence on the outside temperature T_A with which the fresh air is drawn in.

Controller

The minimum selection arrangement 128 in each case selects, from the two setting value signals Y_R and Y_S at its disposal, the smaller one and forwards this onward as y' to the heating valve 170. In this manner there is prevented insofar as possible an overswinging of the temperature to be regulated.

In dependence on the temperature of the supply air, the conveyance of the supply air motor 15 is adjusted over the generated supply air pressure P_{ZU}. For this first of all, in a

controller

$P_{ZU\ SOLL}$ value calculating arrangement 200 shown in Fig. 2, there is determined a desired value $P_{ZU\ SOLL}$ for the supply air pressure. The relation between the supply air temperature T_{ZU} and the supply air pressure $P_{ZU\ SOLL}$ is given in Fig. 6a, and, namely, for the case in which the room temperature $T_{RAUM\ IST}$ is less than the desired value of the room temperature $T_{RAUM\ SOLL}$.

VALUE

Only when the supply air temperature lies clearly above the desired value temperature, in the example of execution by 5 °C, is the desired pressure of the supply air increased. When this supply air temperature is below this threshold, only the volume of air necessary for the ventilation of the rooms is blown into the air-conditioned rooms.

The relation between the room temperature $T_{RAUM\ IST}$ and the desired value of the supply air pressure $P_{ZU\ SOLL}$ is represented in Fig. 6b and, namely, for the case in which the room temperature $T_{RAUM\ IST}$ is greater than the desired value of the room temperature $T_{RAUM\ SOLL}$, or is equal to the desired value for the supply air temperature $T_{RAUM\ SOLL}$.

With increasing actual room temperature $T_{RAUM\ IST}$, when the room temperature is higher than the desired room temperature value $T_{RAUM\ SOLL}$, the air supply temperature T_{ZU} falls and the supply airpressure P_{ZU} falls from its maximal pressure $P_{ZU\ SOLL\ MAX}$ to its minimal pressure $P_{ZU\ SOLL\ MIN}$.

controller

The desired supply air pressure $P_{ZU\ SOLL}$ determined by the $P_{ZU\ SOLL}$ value calculating arrangement 200 in Fig. 2 is compared in the block circuit diagram element 230 with supply air actual pressure

$P_{ZU\ IST}$. The pressure difference P is supplied to the pressure regulation 250.

VALUE

The complete pressure regulating circuit is represented in Fig. 4. The regulating difference ΔP is fed to the regulator 240, which sets-in the setting magnitude Y_P. A limit value switch 245 monitors the setting value Y_P, so that a predetermined minimum pressure $P_{ZU\ MIN}$ which corresponds to a predetermined minimum ventilation volume is not gone below. The setting value Y_P of the limit value switch 245 controls the ventilator 285 in Fig. 4 or 15 in Fig. 1, which generates the pressure of the regulating stretch 286.

controller AIR SUPPLY MOTOR

With the corresponding regulating circuit by an exhaust air motor 16 in the exhaust air channel 11, a subpressure P_{AB} is generated which, for the maintaining of a predetermined excess pressure in the rooms, draws off a corresponding volume of air. The regulation of the exhaust air motor 16 will still be further described below.

through

The tempered supply air in the supply air channel 10 is available over the supply air lines 5 for the ventilating and heating-up of all the rooms 1. With the aid of the throttle clack valves 60, 61, the volume of the air blown in or drawn off in each room is adapted to the particular actual heating requirement. For this in each case there are used the desired temperature, the actual temperature, the supply air temperature and the minimum ventilation volume for the setting of the throttle valves. This regulating circuit, represented in Fig. 2 as a block circuit forming element 300, is reproduced in Fig. 5.

In the block circuit element 310, the individual desired temperature $T_{SOL\ N}$ is compared with the corresponding actual temperature $T_{IST\ N}$; the regulating difference T_N ascertained there is supplied to the regulator 320. On the basis of the temperature difference, ΔT_N, of the supply air temperature T_{ZU} and of the supply air pressure P_{ZU}, this generates a setting signal Y_T which must not fall below a minimal value which is yielded from the actual supply air pressure P_{ZU} and from the minimal pressure $P_{ZU\ MIN}$. The setting signal $Y_{T\ N}$ is fed to the throttle clack valves 330 in Fig. 5, and 60, 61 in Fig. 1. The regulating stretch of this individual temperature regulating circuit is represented by the block circuit element 340.

controller control actual desired

The throttle valves 60, 61 are regulated, therefore, in dependence on the temperature desired value $T_{RAUM\ SOLL}$ in each room individually, on the temperature actual value $T_{RAUM\ IST}$ measured in each individual room, of the temperature value of the supply air temperature T_{ZU}, as well as in dependence on the supply air pressure P_{ZU} and/or the turning rate of the supply air motor.

Speed

As stated above, the regulating circuit ensures, for the adjustment of the opening cross section of the throttle valves 60, 61, a certain minimum opening cross section yielded in dependence on the supply air pressure, which cross section is not gone below in the adjustment of the throttle valves 60, 61. This minimum opening cross section is adjusted there in such manner that each room receives a predetermined absolute minimum fresh air volume.

The minimum opening cross section of the throttle valves 60, 61 is likewise adjusted in dependence on the opening of the fresh air clack valve 70 of the exhaust air clack valve 71 and of the mixed air clack valve 72.

With regulated conveyance volume of the supply air and of the exhaust air the opening settings of the throttle clack valves 60, 61 allocated to one another in a room 1 are equal.

controller

In the regulating of the exhaust air motor 785 according to Fig. 8b, or 16 according to Fig. 1, the desired value for the exhaust air motor is calculated on dependence on the outside temperature in the $P_{DIFF\ SOLL}$ value calculating arrangement 710, in which operation this desired value forms a room excess pressure $P_{DIFF\ SOLL}$ established in respect to the outside pressure P_A in dependence on the outside temperature. The desired value $P_{AB\ SOLL}$ can also be determined in dependence on the supply air temperature and/or on the supply air pressure. in

Gives the

The relation between the outside temperature T_A and the desired value for the exhaust air motor (/ =) desired value for the room excess pressure $P_{DIFF\ SOLL}$, which is yielded from the difference between the desired value of the exhaust air pressure $P_{AB\ SOLL}$ and the outside pressure P_A is represented in Fig. 8c. If the outside temperature T_A exceeds a certain limit value, for example an outside temperature of -10 °C, the desired value $P_{DIFF\ SOLL}$ of the exhaust air motor falls with rising outside temperature from its maximum $P_{DIFF\ SOLL\ MAX}$ to its minimum $P_{DIFF\ SOLL\ MIN}$ with a further limit value, for example with an outside temperature of +15 °C. At an outside temperature before or after this temperature range

established by the two limit values, the desired value of the exhaust air motor $P_{DIFF\ SOLL}$ corresponds either to the maximal room difference pressure $D_{DIFF\ SOLL\ MAX}$ or to the minimal room difference pressure $P_{DIFF\ SOLL\ MIN}$.

controller

The desired value of the exhaust air motor $P_{DIFF\ SOLL}$ determined by the value calculating arrangement 710 in Fig. 8a is compared in the block circuit diagram 700 with the Actual room difference actual pressure value $P_{DIFF\ IST}$ in one room and in several rooms with the supply air and exhaust air channel pressure differential. The pressure difference ΔP is fed To the pressure regulation 730.

difference value

system

The complete pressure regulating circuit is presented in Fig. 8b. The regulating difference ΔP_{DIFF} is fed to the regulator 740, which adjusts the setting magnitude $Y_{P\ DIFF}$. If in a large room, office several windows are open, the exhaust fan can be shut off entirely--only in this way is it possible to maintain a slight excess pressure. With the setting value $Y_{P\ DIFF}$ of the regulator 740, the exhaust air motor 785 in Fig. 8b, or 16 in Fig. 1 which generates the pressure, of the regulating stretch 786 is controlled.

is controlled by controller

The actual value for the regulator 740 of the exhaust air motor 16 or 785 is formed by the actual room difference pressure $P_{DIFF\ IST}$, which is yielded from the difference between the outside pressure P_A and the room pressure $P_{RAUM\ IST} = P_{AB\ IST}$. The room difference pressure $P_{DIFF\ IST}$ is measured there at a level above 0 (sea level).

The form of execution described can be used analogously for the cooling.

In an additional regulating circuit, the air humidity in the air-conditioned rooms is regulated. It is measured preferably as relative air moisture (in percent of the vapor pressure at full saturation) and expressed by a simplified designation F in the following. It is entirely possible, however, to use instead of the relatively humidity, the absolute humidity (g of water vapor per m3 of air), the vapor pressure, the specific moisture (in g H2O per kg of moist air) or as mixture ratio (in g H_2O per kg of dry air). With use of the relative humidity, the dependence on the saturation limit is advantageously integrated into the value. According to the VDI ventilation rules, air humidity should amount in winter, at 20 °C room temperature, to 35% to 70% relative air humidity, and, in summer, at 22 °C air temperature, to 70%, and at 25 °C, to 60%.

In the block circuit element 600 in Fig. 1, there is determined the difference between the desired air moisture $F_{AB\ SOLL}$ and actual air moisture $F_{AB\ IST}$, in which representationally for the air moisture in the individual rooms in the example of execution, the moisture of the exhaust air F_{AB} is measured and adjusted. The determined moisture difference ΔF_{AB} is first introduced into a limit value circuit device 610, which on the basis of predetermined minimal and maximal moisture $F_{AB\ MIN}$ and $F_{AB\ MIN}$, in dependence on the supply and exhaust air temperature, prevents the saturation limit from being exceeded in any place in the air circulation. From this limit value switching device 610, a corrected regulating difference $\Delta F_{AB}'$ is now led to the regulator 620, which controls the air moistener 630 over the control signal Y_L. Thereby, the moisture of the supply air F_{ZU} is adjusted. The regulating stretch is represented by the block circuit diagram element 640.

controller Fed

value value value

The second heating device 33, in the heating case, may also contain the signal Y' of the first heating device 30. The second heating device (33) serves, however, as an after-heater essentially for the dehumidifying. This second heating device (33) is regulated in dependence on the actual value moisture F_{IST} for the desired value moisture, in which with rising actual value moisture F_{IST} over the desired value moisture F_{SOLL} the heating performance of the second heating device (33) rises. The rise of the heating performance of the second heating device (33) moves over a predetermined moisture range of the room moisture F_{IST}. This relation is represented in Fig. 9. At a room moisture F_{IST} before this moisture range, the second heating device (33) is not in operation.

value above

At a room moisture F_{IST} after this moisture range, the second heating device (33)—the after-heater—is in operation with its maximal performance.

By a control arrangement (not represented here) it is made certain that the conveyance volume of the supply air is not increased during the dehumidifying process and that only a minimum amount of fresh air is blown in.

For a better illustration of the regulating system, in the following there is described, by way of example, a warming-up process such as ordinarily takes place in the morning. The block circuit diagram elements participating in the run-off of the regulation are represented in Fig. 10. At the time point when the switching-on of the air-conditioning apparatus takes place, the actual temperatures of all the rooms 1 and the temperature of the drawn-in fresh air lie far above the desired temperature for the rooms 1. Since the temperature of the supply air is still very low, no more supply air is blown into the rooms. For this, a minimal air pressure $P_{ZU\ MIN}$, corresponding to the minimum of fresh air volume, is generated.

At a lower outside temperature below 16 C, the regulator is prior-occupied at the start with a value according to the outside temperature, so that the installation will show no frost disturbance in the starting.

when controller ler

From the actual temperatures of all the rooms 1 to be air-conditioned, the minimum-selection arrangement 400 selects the lowest value and conducts this to the block circuit diagram element 100. Here the regulating difference ΔT between the desired and actual value of the room air temperatures is formed and supplied to the regulator 120 and the control arrangement 127. On the basis of the regulating difference ΔT, the regulator 120 determines a setting value Y_R. Simultaneously with the control arrangement 127, a setting value Y_S is determined, which takes on a maximally great value as long as the desired temperature lies above the actual temperature. Of the two setting values Y_S and Y_R, the minimum selection arrangement 128 selects the smaller one, at this time point the setting value Y_R of the regulator 120, and conducts it onward to the heating device (30). This warms up the air flowing through the air supply channel (10). Therewith, the air supply temperature T_{ZU} rises continuously. From a predetermined temperature threshold value of the air supply, for example $T_{ZU\ SOLL} + 5\ ^{o}C$, with further rising air supply temperature, the air supply pressure also is increased, since the regulation of the air supply pressure occurs in

controller

dependence on the temperature of the air supply. The conveyance volume increases and there takes place a maximally rapid heating-up of all the rooms.

The increased air volume consists not only of fresh air, but a part of the exhaust air again is conducted to the supply air over the environmental air channel 12 in Fig. 1. In this manner, the rooms 1 are sufficiently ventilated and, simultaneously, it is not necessary to heat up much fresh air needlessly.

In the morning heating-up, the fresh air constituent is only—at least—such that the requisite excess pressure is achieved.

Controller

When the heating-up process is concluded, usual commercial regulators do not lower the setting value rapidly enough to prevent a rise of the actual temperatures of the rooms 1 over the desired temperature. For this reason the setting value Y_S of the control ler [arrangement] 127 on exceeding of the desired temperature falls to a predetermined minimal value $Y_{S\ MIN}$. Now the minimum selection [arrangement] 128 selects the value Y_S of the controller [control arrangement] 127 and passes it onward as y' to the heating device 30. Thereupon the air supply temperature again falls, and after a short time the rooms again receive only the minimum fresh air volume that is sufficiently tempered to prevent a lowering of the actual temperature of the air supply below the desired temperature of the air supply. The regulator can therefore slowly reduce its output.

Now there is to be described in addition the case in which only one room has to be heated, while the other rooms have already reached the desired temperature. The selection controller [arrangement] 400 selects the lowest actual temperature of the unheated rooms and passes it on to the block circuit diagram element 100. On the basis of the regulating difference now a setting value y' is set in and the supply air pressure rises correspondingly. So that the rooms will not be supplied with very warm supply air which have already reached the desired temperature, however, the individual room temperature regulation 300[0] regulates the blow-in air volume of the throttle [clack] valves 60, 61 for each room separately.. In this manner the throttle valves 60, 61 of the rooms in which the actual temperature are closed to the minimum opening, which ensures that the rooms are sufficiently ventilated. Simultaneously, the throttle valves 60, 61 of the room being heated rising Tzu is opened up by the PDIFF, up to 100%, in order to make possible a rapid heating-up. Only when this room has reached its desired temperature does the air-conditioning regulation again set in the minimum ventilation and desired temperature holding state.

It will be apparent to those skilled in the art that various modifications and variations can be made in the air-conditioning apparatus of the present invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this inventions provided they come within the scope of the appended claims and their equivalents.

ABSTRACT

Through

The invention relates to an air-conditioning apparatus which regulates at least the temperature of at least one room to a predetermined temperature desired value ($T_{RAUM\ SOLL}$) by ventilation with heated or cooled supply air. The air-conditioning apparatus has a supply air motor (15) which feeds the supply air over a supply air channel (10) to the room (1) to be air-conditioned, a cooling and/or heating device (30, 40 33) for the cooling or warming of the supply air, and an exhaust air motor (16) which draws the exhaust air from the room (1) to be air-conditioned over an exhaust air channel (11). According to the invention, the desired value ($P_{AB\ SOLL}$) for the regulator of the exhaust air motor (16) forms a room excess pressure established with respect to the outside pressure (P_A).

Through

AIR- CONDITIONING APPARATUS

FIELD OF INVENTION

The invention relates to an air-conditioning apparatus which regulates the temperature in at least one room by ventilation with heated or cooled air to a predetermined desired temperature value.

BACKGROUND OF THE INVENTION

Air-conditioning apparatuses are used to create in the air-conditioned rooms comfortable conditions of occupation at any time of year, as they hold the temperature and humidity of the room air within fixed limits' and provide for a sufficient ventilation with fresh air.

In winter the supply air temperature is higher than the room air temperature when the air is also meant to warm the room, and in summer the supply air is injected at a lower temperature in order to hold the room at the desired cooled room air temperature.

Ordinarily, to achieve this, a conventional air-conditioning apparatus circulates too high an amount of air, the temperature of which has been adapted to the heating and cooling requirement. This is regarded as disadvantageous as a large volume of air is circulated even after the desired temperature has already been reached. Moreover, the danger exists that the supply air will be blown into the room through the supply air channel and will immediately leave the room to be air-conditioned through the exhaust air channel. There takes place very little mixing of the new supply air with the air present in the room.

Further, when air-conditioning several rooms, there is the problem that different desired temperatures are sought in the different rooms. An adaptation of the temperatures which takes into consideration the comfort in each room is possible only with difficulty.

SUMMARY OF THE INVENTION

Underlying the present invention is the problem of providing an air-conditioning apparatus which operates economically, ensures more comfortable room conditions and an optimal mixing of the room air with the supply air, in order to achieve a rapid adaptation to the desired heating, cooling, humidifying and dehumidifying values.

This problem is solved according to the invention by an air-conditioning apparatus which regulates the temperature in at least one room to a predetermined desired temperature value by ventilation with heated or cooled air. The apparatus is provided with a supply air motor which feeds the supply air through a supply air channel to the room to be air-conditioned, with a cooling and/or heating device introduced into the supply air channel for the cooling or warming of the supply air, and with an exhaust air motor which draws the exhaust air through an exhaust channel out of the room to be air-conditioned, in which the desired value for the regulator of the exhaust air motor builds up a room excess pressure established with respect to the outside pressure. Further advantageous embodiments of the invention form the objects of the subclaims.

Underlying the invention is the perception that the greater the excess pressure is in a room to be air-conditioned, the better is the ventilation by the supply air blown through the room. Therefore, the room warms up faster, the efficiency of the

installation is improved and great temperature fluctuations in the room are avoidable for example, very warm at the top and very cool at the bottom, as are also temperature differences over the length and width of the room.

A good flow of air through the room ensures that in the shortest possible time and with a smaller amount of air, a room is heated, cooled, humidified or dehumidified. The smaller amount of supply air blown in is found pleasant. Because of the faster adaptation to the desired heating, cooling, humidifying and dehumidifying values, the efficiency of the air-conditioning apparatus is improved.

In particular, the desired value for the regulator of the exhaust air motor is determined in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure. This regulating of the exhaust air motor, in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure, is important for the optimization of the air flow. The higher the supply air temperature or the supply air pressure is, the greater the excess pressure would have to be for a favorable flow of air through the room to be air-conditioned with the supply air. The lower, however, the outside temperature is, the higher as a rule, therefore, the excess pressure in the room to be air-conditioned has to be. There must, therefore, be present a greater excess pressure for ensuring an optimal flow of air through the room with the blown-in supply air.

On the one hand, preferably the actual value for the regulator of the exhaust air motor is determined by a pressure difference between the channels, which is calculated from the difference between the absolute value of the pressure in the supply air channel and the absolute value of the pressure in the exhaust air channel. It will then be the case that, for example, excess pressure disturbances

will occur in the air-conditioning apparatus in several rooms as a result of opening of windows in individual rooms, and therefore this results in an undesired rise in the excess pressure in the other rooms, taking place through the regulation of the exhaust air motor, by reason of the pressure loss in one room.

On the other-hand, preferably the actual value for the regulator of the exhaust air motor is formed by the room pressure difference which is calculated from the difference between the outside pressure and the room pressure. -

Here above all, the room excess pressure varies exclusively over a predetermined temperature range of the outside temperature and/or of the supply air temperature, with a change in the outside temperature or of the supply air temperature, in which with an outside temperature below this temperature range, the room excess pressure has in each case a certain constant value, and, with an outside temperature or supply air temperature above this temperature range, the room excess pressure always has a further definite constant value. Above all, with rising outside temperature, in that temperature range, the room pressure falls from a maximum excess pressure to a minimal excess pressure.

Thereby account is taken of two opposite demands. On the one hand, for a good flow of air through the room to be air-conditioned, it is required that the excess pressure be as high as possible. On the other hand, the excess pressure must not be too great, because it is otherwise felt to be disagreeable, and with too great excess pressure, doors open themselves or no longer can be opened or are closed only with a high expenditure of force.

So that a comfortable regulation will be accomplished and an excess pressure will be ensured independently from the height or the floor level of the room to be air-

conditioned, the room difference pressure is measured at a height or level over 0 (room height). Room height corresponds to outside elevation in respect to sea level.

According to one embodiment of the invention, the temperature of the supply air and the channel pressure of the supply air are coupled with one another in such a manner that both, in dependence on the value of the room temperature to the value of the supply air temperature and also in dependence on the value of the room temperature to the desired value of the room temperature, the channel pressure of the supply air is raised or lowered in the room, rooms or room zones.

The advantages herewith achieved lie especially in that a great volume of air-conditioned air is not unnecessarily circulated, but always only that volume is used that is required for a maximally rapid adaptation of the actual room values to the predetermined desired values.

In this manner not only are savings in energy achieved, but people in the room find it considerably more agreeable when a relatively strong air movement takes place only when the temperature of the blown-in air deviates from the actual temperature. With conventional air-conditioning apparatuses, in contrast, especially during the morning warming-up phase, even at a room temperature that lies far below the desired value, only slightly warmed supply air is blown into the rooms at a high channel pressure. This was hitherto felt to be disagreeable by the persons concerned, but it was regarded as unavoidable.

According to the present embodiment of the invention, heated air with the higher channel pressure is blown into the room only if the temperature of the supply air lies clearly above the predetermined desired temperature of the room and

therewith, in the warming-up phase, lies far above the actual value of the room. By a relation regulation in which the channel pressure of the supply air is set in a fixed relation to the supply air temperature, a corresponding coupling of channel pressure of the supply air pressure to the supply air temperature can be realized especially advantageously.

Preferably the channel pressure of the supply air into the room, the rooms, or the room zones is adjusted over the range of the supply air motor.

For a selecting arrangement, a choice can be made between two delivery volume relations.

In the first place, for the heating case in which the desired value of the room temperature is less than the actual value of the room temperature, the channel pressure of the supply air is lowered with rising room temperature. Correspondingly, for the cooling case in which the desired value of the room temperature is greater than the actual value of the room temperature, the channel pressure of the supply air is lowered with falling room temperature. In the second place, for the heating case in which the desired value or the actual value of the room temperature is less than the supply air temperature and the actual value of the room temperature is less than the desired value of the room temperature, the channel pressure of the supply air is raised with rising supply air temperature. Correspondingly, for the cooling case in which the desired value or actual value of the room temperature is greater than the supply air temperature and the actual value of the room temperature is greater than the desired value of the room temperature, the channel pressure is raised with falling supply air temperature. The increase of the channel pressure of the supply air is found to be pleasant.

Moreover, the efficiency of the heating and cooling apparatus is improved, as will be stated again further below.

According to a further embodiment of the invention, the channel pressure of the supply air varies exclusively over a predetermined temperature range of the supply air temperature. If the supply air temperature presents a value below this temperature range, then the channel pressure of the supply air is allocated in each case to a certain constant magnitude. If the supply air temperature presents a value above the temperature range, then the channel pressure of the supply air is allocated in each case to a further determined constant magnitude.

In particular, with a supply air temperature higher with respect to the room temperature, the channel pressure rises over the predetermined temperature range of the channel pressure from its minimum performance up to its maximum performance with rising supply air temperature, and it correspondingly falls with falling supply air temperature.

Through the two regulating systems of the supply air channel pressure behavior, on the one hand, it is made possible for the efficiency of the air-conditioning apparatus to be improved. With higher channel pressure of the supply air, there is achieved also a more rapid and better flow through the room, and therewith a faster heating up of the rooms. On the other hand, for reasons of comfort, too great an air flow should be avoided, since this is felt to be disagreeable. The opposite demands are now optimally satisfied.

Here, the regulating circuit which regulates the channel pressure of the supply air is subordinated to the temperature regulating circuit; the desired supply channel pressure value being set in a fixed relation to the actual value of the supply air

temperature. Herewith there is avoided any excessive increasing or decreasing in the temperature regulation. The room temperature swings back faster to the desired temperature value.

With air-conditioning for several rooms, the heated supply air is made available through a common supply air channel. In the case of different desired and actual temperatures of all the rooms, however, each room has a different heating requirement. In order to take this circumstance into account, according to a further form of execution of the invention, in the simultaneous air-conditioning of several rooms or room zones, the individual rooms or room zones are connected in each case through a supply air and an exhaust air line allocated to them from the central supply air and exhaust air channels, and in the individual supply air and/or exhaust air lines, throttle valves are arranged through which the channel pressure of the supply air is adjusted in the rooms or room zones.

Thereby undesired air movements are avoided in rooms, the actual and desired values of which are alike or approximately alike. Moreover it is achieved that, for example, in the case of a fully open fresh air control valve, an excessive amount of fresh air is not worked up.

The regulation of the control valves can occur additionally in dependence on supply air pressure or on the speed of the supply air motor.

In such an independent regulation of supply air temperature and individual room temperature, a situation can arise in which a single room has to be heated as rapidly as possible, but other rooms that already lie at their desired temperature are to be heated up as little as possible. When the supply air temperature rises, the individual regulation of these warm rooms will tend to close the control valves.

Therewith, however, these rooms and the persons present in them are cut off from the fresh air supply.

This problem is advantageously solved according to a further embodiment, in which at a supply air temperature that lies above the desired temperature, in rooms the actual temperature of which corresponds to the desired temperature, the requisite minimum volume of fresh air also is blown. In this manner it is achieved that these rooms are supplied with sufficient fresh air; nevertheless, a possible warming of the rooms by reason of a supply air temperature that lies above the desired temperature is avoided insofar as possible. The minimum opening required for the prescribed minimum fresh air volume depends on the supply air temperature and on the fresh air component of the supply air, for the fresh air component of the supply air is reduced, if possible, during the warming-up phase in the morning for a maximally rapid heating up, being replaced by return air.

According to one embodiment, the exhaust air channel and the supply air channel are connected with one another through a return air channel, in which case at least one air exhaust throttle control valve is provided in the return air channel, and at least one fresh air throttle control valve is provided in the fresh air channel engaged ahead of the supply air channel.

According to a further embodiment, the minimum cross section of the throttle control valves is adjusted in dependence on the opening of the fresh air throttle control valve, of the exhaust air throttle control valve and of the mixing air throttle control valve, so that in each regulation situation there is ensured the minimum amount of fresh air.

With regulated channel pressure for the supply air and for the exhaust air, the opening positions of the throttle control valves allocated relative to one another in a room or in a room zone are equal.

Analogously to the heating regulation, there can also take place a cooling regulation.

For the temperature regulation, regulators are used. In practice, these regulators tend to an overswinging and underswinging of the regulating value.

According to a further embodiment of the invention, in each case the setting value of at least one regulator, especially of the temperature regulator, is connected to a subordinated switching arrangement, and the switching arrangement, in the case of an overswinging (exceeding) of the regulating value, selects a value predetermined for it, as the setting value, which clearly lies under the value chosen simultaneously by the regulator.

Such a behavior can advantageously be obtained by an additional control arrangement and a minimum-selection arrangement. This additional control arrangement delivers, in dependence on the regulating difference, a predetermined minimal value for the setting magnitude when an overswinging of the regulating value occurs, and a predetermined maximal value of the setting value when the actual value of the temperature (the regulating value) lies below the desired value. The minimum selection arrangement then in each case selects the minimum, from the values made available by the regulator and the additional control arrangement and forwards the selected value as the setting value. In this manner the additional control arrangements always take over the control of the setting value when by reason of the setting value of the regulator, an

overswinging (exceeding) occurs in the regulating value.

According to a further embodiment of the invention, there are provided a fresh air control valve in a fresh air channel engaged on an inlet side of the supply air channel, a mixed air control valve in a return air channel connecting the supply air channel with the exhaust air channel, and a discharge air control valve in a discharge air channel connecting to the exhaust air channel, in which situation the settings of the fresh air control valve, of the discharge air control valve and of the mixed air control valve are regulated in common dependence on the speed of the supply air motor or on the channel pressure of the supply air, and in which up to a certain minimal opening for ensuring a fresh air minimum, with increasing speed of the supple air motor and /or with rising channel pressure of the supply air, the opening cross sections of the fresh air control valve and of the discharge air control valve can be reduced and the opening cross section of the mixed air control valve can be increased.

The opening position of the fresh air control valve and the opening position of the exhaust air control valve are always of equal size. The opening position of the mixed air control valve is always the difference of the opening position of the fresh air or exhaust air control valve to 100%, for example, if the opening positions of the fresh air control valve and exhaust air throttle control valve are each case 70%, then the opening position of the mixed air control valve is 30%. If the mixed air control valve has an opening position of 70%, then the opening positions of the fresh air and exhaust air control valves are in each case 30%.

In a further preferred embodiment of the invention, more than one room is air--conditioned from a central installation. In the case of different heating requirements for the individual rooms, it is also necessary to make available

through the supply air a sufficient heating capacity for all the rooms. This can be achieved inter alia by the means that the heating required is measured in accordance to the actual temperature of the coldest room, in order to bring also this room to the desired temperature in a short time. Accordingly, in one form of execution of the invention, in the simultaneous air-conditioning of several rooms, the actual temperature of each room is fed to a central regulating arrangement, and a temperature value to be determined individually from these individual actual values, is supplied as an actual value for the heating regulator -

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According to a further embodiment of the invention, a humidifying arrangement is provided which humidifies the supply air in the supply air channel, in which process the humidifying arrangement is regulated both in dependence on the room moisture or the exhaust air moisture as well in dependence on the supply air temperature.

According to a further embodiment of the invention, there are provided a first heating device installed in the supply air channel, a cooling device located after the first heating device in the supply air channel, and a second heating device installed after the cooling device in the supply air channel for the heating, cooling and dehumidifying of the supply air, the second heating device being regulated for the desired moisture value in dependence on the actual moisture value.

In particular with a rising actual humidity value which already lies above the desired humidity value, the heating performance of the second heating device rises.

The heating performance of the second heating device is regulated either with a regulator or it climbs with rising actual moisture value over a predetermined

moisture range of the room moisture; at a room moisture content below this moisture range, the heating performance has in each case a certain constant magnitude and at a room moisture above the moisture range, the heating performance has in each case a further determined constant magnitude.

It is hereby achieved that a dehumidifying is brought about over a rising room temperature insofar as the actual value of the room temperature remains under the limit value from which the cooling process is initiated. Cooling starts only when the actual value of the room temperature is greater than the desired value of the room temperature plus the temperature displacement dependent on the outside temperature. By the heating-up, and therewith, the dehumidifying of the room over the rising temperature, the room is rapidly dehumidified with a relatively low expenditure of energy.

The channel pressure of the supply air is not raised during the dehumidifying process.

In order to guarantee a minimum amount of fresh air in the room or the rooms, the regulation of the fresh air control valve and of the discharge air control valve occurs in dependence on the opening position of the mixed air control valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings, which are included to provide further understanding of the present invention and are incorporated in and constitute a part of this specification, illustrate the preferred embodiments of the invention and together with the description serve to explain the principles of the invention.

In the simplest case, a single room is tempered and ventilated with the air-conditioning apparatus. The regulation of a multi-room air-conditioning is described in the example of execution with the aid of the drawings, in which:

Fig. 1 shows a schematic representation of the air circulation in an air-conditioning apparatus according to the invention.

Fig. 2 is a block circuit diagram with the most important elements of the regulating and control arrangements in an example of execution.

Fig. 3 is a block circuit diagram with important elements of the temperature regulating circuit from Fig. 2.

Fig. 4 is a block circuit diagram of a conveyance volume regulating circuit of the supply air from Fig. 2.

Fig. 5 is a block circuit diagram of an individual temperature regulating circuit for each room from Fig. 2.

Fig. 6a shows the relation between the supply air temperature and the supply air pressure for the example of execution when the room actual temperature is less than the desired room temperature value.

Fig. 6b shows the relation between the room temperature and the supply air pressure for the example of execution when the actual room temperature is greater than or equal to the desired room temperature value.

Fig. 7 is a block circuit diagram of the temperature regulator of the example of execution.

Fig. 8a is a block circuit diagram of the regulator of the exhaust air motor of the example of execution.

Fig. 8b is a block circuit diagram with the most important elements from Fig. 8a.

Fig. 8c shows the relation between the desired value of the room difference pressure for the regulator of the exhaust air motor.

Fig. 9 shows the relation between the room exhaust air moisture and the setting value for the after-heater.

Fig. 10 is a run-off diagram with the most important block circuit diagram elements participating in the heating-up process.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1 there is schematically represented the air circulation of a multi-room air-conditioning system. From the rooms 1 to be air-conditioned there lead, on the one hand, supply air lines 5 to a supply air channel 10 and, on the other hand, exhaust air lines 6 to an exhaust air channel 11.

In the supply air line 5 there is arranged in each case a throttle control valve 60 and in the exhaust air line 6 in each case a throttle control valve 61.

The supply air channel 10 and the exhaust air channel 11 are connected. with one another through a return air channel 12.

On inlet side of the supply air channel 10 there is engaged a fresh air channel 20 and on the outlet side of the exhaust air channel 11 there is engaged an exhaust air channel 21.

In the fresh air channel 20 there is provided a fresh air throttle control valve 70, in the return air channel 12 a mixed air throttle control valve 72 and in the exhaust air channel 21 an exhaust air throttle control valve 71.

In the supply air channel 10 there are arranged successively in flow direction of the air a first heating device 30, a cooling device 40, a second heating device 33, a supply air motor 15 and a humidifying device 50.

In the supply air channel there is generated by the supply air motor 15 an air pressure P_{ZU} which provides that the supply air is blown with sufficient conveyance volume into the rooms 1 to be air-conditioned.

Correspondingly in the exhaust air channel 11 there is generated by the exhaust air motor 16 a subpressure P_{AB}, which draws off the room air.

In the simplest case, the pure airing case (office operation), the drawn off room air(i.e. the exhaust air) is taken off through the exhaust air channel 11 and the exhaust air channel 21 to the outer atmosphere, and through the fresh air channel 20, the required supply air is drawn as fresh air into the supply air channel 10. For this, the fresh air throttle control valve 70 and the exhaust air throttle control valve 71 are opened and the mixed air throttle control valve 72 is closed. The fresh air

throttle control valve 70 and the exhaust air throttle control valve 71, always have equal opening settings.

In order to make possible a warming-up of the air-conditioned rooms 1, the drawn-in fresh air flows through the first heating device 30 (preheater) through which drawn-in air is brought according to a heating requirement to the requisite supply air temperature T_{ZU}. After passing the disengaged cooling device 40 and the second heating device 33 (afterheater), it is fed to the humidifying device 50, which supplies the necessary moisture to the air.

Instead of the first heating device 30, in a required cooling of the rooms to be air conditioned, the cooling device 40 is in operation. In the case of excessive humidity, instead of the humidifying device 50, the afterheater 33 is in operation for the dehumidifying. In order to ensure a more rapid heating-up, both the first heating device 30 and also the second heating device 33 can be in operation. This, however is possible for the heating case, not for the dehumidifying case.

The air worked-up in this way is fed to the individual rooms to be air-conditioned, through the supply air motor 15, the supply air channel 10 and the supply air lines 5, with the throttle control valves 60. The volume of the air blown-in and drawn off from each individual room can be regulated by the throttle control valves 60, 61 arranged in the supply air lines 5 and in the exhaust air lines 6 individually.

In the case of increased heat requirement, for example in the morning warm-up phase, it is advantageous to supply the rooms not only with drawn-in fresh air, but to use a part of the drawn-off room air repeatedly, for in the simultaneous warming-up and ventilation the required supply air volume lies far above the fresh air minimum volume. For this reason, in dependence on the supply air

temperature T_{ZU} through a control arrangement (controller) 500 in Fig. 2, a setting value Yv is calculated and supplied to the air throttle control valves 550 in Fig. 2, or 70, 71, 72 in Fig.1.

While the fresh air throttle control valve 70 and the exhaust air throttle control valve 71 receive the same control signal, the mixed air throttle control valve 72 in the return air channel 12, is supplied the exactly opposite control signal. The open position of the mixed air throttle control valve 72 is always the difference between the open position of the fresh air control valve 70 or of the exhaust air control valve 71 and 100%. For example, the open position of the fresh air control valve 70 and of the exhaust air control valve 71 amounts in each case to 70%, then the open position of the mixed air control valve 30 amounts to 30%. If the mixed air control valve has an open position of 70%, then the open position of the fresh air control valve 70 and of the exhaust air control valve 71 is in each case 30%.

In this manner it is possible again to feed a certain proportion of the drawn-off room air through the return air channel 12 to the supply air. Simultaneously through the fresh air channel 20 and the fresh air control valve 70, a corresponding fresh air component is supplied to the supply air. This fresh air component amounts in the example of execution in the airing case (during the office hours) to up to 100%. During office hours, therefore, the mixed air control valve 72 as a rule is not opened, and the fresh air control valve 70 and the exhaust air control valve 71 are normally opened to 100% each. With increased heating requirement and a maximal supply air pressure $P_{ZU\,MAX}$ the fresh air component falls to approximately 10%--warming-up phase in the morning.

In the air-conditioning, from the measured room temperatures $T_{RAUM\ IST1}$, $T_{RAUM\ IST2}$ or $T_{RAUM\ IST\ N}$ in the minimal selection controller 400 in Fig. 2, the lowest value $T_{RAUM\ IST\ MIN}$ is determined and used for the calculation of the heating requirement. For this, the actual temperature $T_{RAUM\ IST\ MIN}$ in the block circuit diagram element 100 is subtracted from the predetermined (maximal) desired temperature $T_{RAUM\ SOLL}$ (of all the rooms). On the basis of the temperature difference T (regulating difference), by the temperature regulation system 130, there is determined a suitable desired value y' for the heating valve 170 of the heating device 30 in Fig. 1.

The setting value Yr calculated in Fig. 3 for the temperature regulation is monitored by the switching controller 125 arranged on an outlet side in order largely to prevent an overswinging of the temperature usual with conventional regulators. In the normal case, as long as $T_{RAUM\ IS\ MIN}$ lies below $T_{RAUM\ SOLL}$, the switching controller 125 forwards the setting value Y_R unaltered as y' onward to the heating valve 170. If, however, $T_{RAUM\ IST\ MIN}$ exceeds the desired temperature $T_{RAUM\ SOLL}$ then, instead of Y_R a much smaller setting value y' will be forwarded on to the heating valve 170. The value of the setting magnitude y' assures in this case the minimally required supply air temperature $T_{ZU\ MIN}$, which is dependent on the outside temperature T_A. In this manner with the example of execution, there is achieved a maximal overswinging of the desired temperature by only 0.3°C; a falling below this virtually does not take place.

The monitoring of the setting signal Y_R of the regulator 120 is executed in the example of execution by a switching controller 127 in Fig. 7 and a minimum selection controller 128. The control arrangement simultaneously generates, for the regulator 120, a setting signal Y_S which takes on a maximally great value as

long as the desired temperature $T_{RAUM\ SOLL}$ lies above the actual temperature $T_{RAUM\ IST}$ and moves down to the very low setting $Y_{S\ MIN}$ as soon as the actual temperature exceeds the desired value.

The setting value $Y_{S\ MIN}$ of the controller 128 is adjusted by the computing system 129 for the cutting-off of the otherwise occurring underswinging of the temperature regulation in dependence on the outside temperature T_A with which the fresh air is drawn in.

The minimum selection controller 128 in each case selects, from the two setting value signals Y_R and Y_S at its disposal, the smaller one and forwards this onward as y' to the heating valve 170. In this manner there is prevented, insofar as possible, an overswinging of the temperature to be regulated.

In dependence on the temperature of the supply air, the conveyance of the supply air motor 15 is adjusted over the generated supply air pressure P_{ZU}. For this first of all, in a $P_{ZU\ SOLL}$ value calculating controller 200 shown in Fig. 2, there is determined a desired value $P_{ZU\ SOLL}$ for the supply air pressure. The relation between the supply air temperature T_{ZU} and the supply air pressure $P_{ZU\ SOLL}$ is given in Fig. 6a, for the case in which the room temperature $T_{RAUM\ IST}$ is less than the desired value of the room temperature $T_{RAUM\ SOLL}$

Only when the supply air temperature lies clearly above the desired temperature value, in the example of execution by 5°C, is the desired pressure of the supply air increased. When this supply air temperature is below this threshold, only the volume of air necessary for the ventilation of the rooms is blown into the air-conditioned rooms.

The relation between the room temperature $\mathbf{T}_{\mathbf{RAUM\ IST}}$ and the desired value of the supply air pressure $\mathbf{P}_{\mathbf{ZU\ SOLL}}$ is represented in Fig. 6b, for the case in which the room temperature $\mathbf{T}_{\mathbf{RAUM\ IST}}$ is greater than the desired value of the room temperature $\mathbf{T}_{\mathbf{RAUM\ SOLL}}$, or is equal to the desired value for the supply air temperature $\mathbf{T}_{\mathbf{RAUM\ SOLL}}$.

With increasing actual room temperature $\mathbf{T}_{\mathbf{RAUM\ IST}}$, when the room temperature is higher than the desired room temperature value $\mathbf{T}_{\mathbf{RAUM\ SOLL}}$, the air supply temperature T_{ZU} falls and the supply air pressure P_{ZU} falls from its maximal pressure $\mathbf{P}_{ZU\ SOLL\ MAX}$ to its minimal pressure $\mathbf{P}_{\mathbf{ZU\ SOLL\ MIN}}$.

The desired supply air pressure $\mathbf{P}_{ZU\ SOLL}$ determined by the $\mathbf{P}_{\mathbf{ZU\ SOLL}}$ value calculating controller 200 in Fig. 2 is compared in the block circuit diagram element 230 with supply air actual pressure $\mathbf{P}_{ZU\ IST}$. The pressure difference P is supplied to the pressure regulator 250.

The complete pressure regulating circuit is represented in Fig. 4. The regulating difference ΔP is fed to the regulator 240, which sets-in the setting value $\mathbf{Y}_{\mathbf{P}}$. A limit value switch 245 monitors the setting value $\mathbf{Y}_{\mathbf{P}}$, so that a predetermined minimum pressure $\mathbf{P}_{\mathbf{ZU\ MIN}}$ which corresponds to a predetermined minimum ventilation volume is not gone below. The setting value Y_P of the limit value switch 245 controls the air supply motor 285 in Fig. 4 or 15 in Fig. 1, which generates the pressure of the process regulating controller 286.

With the corresponding regulating circuit by an exhaust air motor 16 in the exhaust air channel 11, a subpressure $\mathbf{P}_{\mathbf{A\ B}}$ is generated which, for the maintaining

of a predetermined excess pressure in the rooms, draws off a corresponding volume of air. The regulation of the exhaust air motor 16 will still be further described below.

The tempered supply air in the supply air channel 10 is available through the supply air lines 5 for the ventilating and heating-up of all the rooms 1. With the aid of the throttle valves 60, 61, the volume of the air blown in or drawn off in each room is adapted to the particular actual heating requirement. For this in each case there are used the desired temperature, the actual temperature, the supply air temperature and the minimum ventilation volume for the setting of the throttle valves. This regulating circuit, represented in Fig. 2 as a block circuit forming element 300, is reproduced in Fig. 5.

In the block circuit element 310, the individual desired temperature $\mathbf{T}_{\mathbf{SOL\,N}}$ is compared with the corresponding actual temperature $\mathbf{T}_{\mathbf{IST\,N}}$; the regulating difference T_N ascertained there is supplied to the regulator 320. On the basis of the temperature difference, ΔT_N, of the supply air temperature T_{ZU} and of the supply air pressure P_{ZU}, this generates a setting signal Y_T which must not fall below a minimal value which is yielded from the actual supply air pressure P_{ZU} and from the minimal pressure $\mathbf{P}_{\mathbf{ZU\,MIN}}$. The setting signal $\mathbf{Y}_{\mathbf{T\,N}}$ is fed to the throttle control valves 330 in Fig. 5, and 60, 61 in Fig. 1. The regulating controller of this individual temperature regulating circuit is represented by the block circuit element 340.

The throttle valves 60, 61 are regulated, therefore, in dependence on the desired temperature value $T_{RAUM\,SOLL}$ in each room individually, on the actual temperature value $\mathbf{T}_{\mathbf{RAUM\,IST}}$ measured in each individual room, of the temperature value of the supply air temperature T_{ZU}, as well as in dependence on the supply air pressure

P_{ZU} and/or the speed of the supply air motor.

As stated above, the regulating circuit ensures, for the adjustment of the opening cross section of the throttle valves 60, 61, a certain minimum opening cross section yielded in dependence on the supply air pressure, which cross section is not gone below in the adjustment of the throttle valves 60, 61. This minimum opening cross section is adjusted there in such manner that each room receives a predetermined absolute minimum fresh air volume.

The minimum opening cross section of the throttle valves 60, 61 is likewise adjusted in dependence on the opening of the fresh air valve 70, of the exhaust air valve 71 and of the mixed air valve 72.

With regulated conveyance volume of the supply air and of the exhaust air, the opening settings of the throttle valves 60, 61 allocated to one another in a room 1 are equal.

In the regulating of the exhaust air motor 785 according to Fig. 8b, or 16 according to Fig. 1, the desired value for the exhaust air motor is calculated in dependence on the outside temperature in the $\mathbf{P}_{\mathbf{DIFF\ SOLL}}$ value calculating controller 710, in which operation this desired value forms a room excess pressure $\mathbf{P}_{\mathbf{DIFF\ SOLL}}$ established in respect to the outside pressure $P_{\mathbf{A}}$ in dependence on the outside temperature. The desired value $\mathbf{P}_{\mathbf{AB\ SOLL}}$ can also be determined in dependence on the supply air temperature and/or on the supply air pressure.

The relation between the outside temperature $T_{\mathbf{A}}$ and the desired value for the exhaust air motor gives the desired value for the room excess pressure $\mathbf{P}_{\mathbf{DIFF\ SOLL}}$,

which is yielded from the difference between the desired value of the exhaust air pressure $\mathbf{P_{AB\ SOLL}}$ and the outside pressure P_A, is represented in Fig. 8c. If the outside temperature T_A exceeds a certain limit value, for example an outside temperature of -10°C, the desired value $\mathbf{P_{DIFF\ SOLL}}$ of the exhaust air motor falls with rising outside temperature from its maximum $\mathbf{P_{DIFF\ SOLL\ MAX}}$ to its minimum $\mathbf{P_{DIFF\ SOLL\ MIN}}$ with a further limit value, for example with an outside temperature of +15°C. At an outside temperature before or after this temperature range established by the two limit values, the desired value of the exhaust air motor $\mathbf{P_{DIFF\ SOLL}}$ corresponds either to the maximal room difference pressure $D_{DIFF\ SOLL\ MAX}$ or to the minimal room difference pressure $P_{DIFF\ SOLL\ MIN}$.

The desired value of the exhaust air motor $P_{DIFF\ SOLL}$ determined by the value calculating controller 710 in Fig. 8a is compared in the block circuit diagram element 700 with the actual room pressure difference value $P_{DIFF\ IST}$ in one room and in several rooms with the supply air and exhaust air channel pressure differential. The pressure difference ΔP is fed to the pressure regulation system 730.

The complete pressure regulating circuit is presented in Fig. 8b. The regulating difference ΔP_{DIFF} is fed to the regulator 740, which adjusts the setting value $Y_{P\ DIFF}$. If in a large room, several windows are open, the exhaust fan can be shut off entirely--only in this way is it possible to maintain a slight excess pressure. With the setting value $Y_{P\ DIFF}$ of the regulator 740, the exhaust air motor 785 in Fig. 8b, or 16 in Fig. I which generates the pressure is controlled by the regulating controller 786.

The actual value for the regulator 740 of the exhaust air motor 16 or 785 is formed by the actual room difference pressure $P_{DIFF\ IST}$, which is yielded from the

difference between the outside pressure P_A and the room pressure $P_{RAUM\ IST} = P_{AB\ IST}$. The room difference pressure $P_{DIFF\ IST}$ is measured there at a level above 0 (sea level).

The form of execution described can be used analogously for the cooling.

In an additional regulating circuit, the air humidity in the air-conditioned rooms is regulated. It is measured preferably as relative air moisture (in percent of the vapor pressure at full saturation) and expressed by a simplified designation F in the following. It is entirely possible, however, to use instead of the relative humidity, the absolute humidity (g of water vapor per m^3 of air), the vapor pressure, the specific moisture (in g H_20 per kg of moist air) or as mixture ratio (in g H_20 per kg of dry air). With use of the relative humidity, the dependence on the saturation limit is advantageously integrated into the value. According to the VDI ventilation rules, air humidity should amount in winter, at 20°C room temperature, to 35% to 70% relative air humidity, and, in summer, at 22°C air temperature, to 70%, and at 25°C, to 60%.

In the block circuit element 600 in Fig. 1, there is determined the difference between the desired air moisture $F_{AB\ SOLL}$ and actual air moisture $F_{AB\ IST}$, in which representationally for the air moisture in the individual rooms in the example of execution, the moisture of the exhaust air F_{AB} is measured and adjusted. The determined moisture difference ΔF_{AB} is first introduced into a limit value circuit device 610, which on the basis of predetermined minimal and maximal moisture $F_{AB\ MIN}$ and $F_{AB\ MIN}$ in dependence on the supply and exhaust air temperature, prevents the saturation limit from being exceeded in any place in the air circulation. From this limit value switching device 610, a corrected regulating difference $\Delta F_{AB'}$ is now fed to the regulator 620, which controls the air moistener

630 over the control signal Y_L. Thereby, the moisture of the supply air F_{ZU} is adjusted. The regulating controller is represented by the block circuit diagram element 640.

The second heating device 33, in the heating case, may also contain the signal Y' of the first heating device 30. The second heating device (33) serves, however, as an after-heater essentially for the dehumidifying. This second heating device (33) is regulated in dependence on the actual moisture value F_{IST} for the desired moisture value, in which with rising actual moisture value F_{IST} over the desired moisture value F_{SOLL} the heating performance of the second heating device (33) rises. The rise of the heating performance of the second heating device (33) moves over a predetermined moisture range of the room moisture F_{IST}. This relation is represented in Fig. 9. At a room moisture F_{IST} before this moisture range, the second heating device (33) is not in operation.

At a room moisture value F_{IST} above this moisture range, the second heating device (33)--the after-heater--is in operation with its maximal performance.

By a control arrangement (not represented here) it is made certain that the conveyance volume of the supply air is not increased during the dehumidifying process and that only a minimum amount of fresh air is blown in.

For a better illustration of the regulating system, in the following there is described, by way of example, a warming-up process such as ordinarily takes place in the morning. The block circuit diagram elements participating in the run-off of the regulation are represented in Fig. 10. At the time point when the switching-on of the air-conditioning apparatus takes place, the actual temperatures of all the rooms 1 and the temperature of the drawn-in fresh air lie

far above the desired temperature for the rooms 1. Since the temperature of the supply air is still very low, no more supply air is blown into the rooms. For this, a minimal air pressure $P_{ZU\,MIN}$, corresponding to the minimum of fresh air volume, is generated.

At a lower outside temperature below 16° C, the regulator is prior-occupied at the start with a value according to the outside temperature, so that the installation will show no frost disturbance when starting.

From the actual temperatures of all the rooms 1 to be air-conditioned, the minimum-selection controller 400 selects the lowest value and conducts this to the block circuit diagram element 100. Here the regulating difference ΔT between the desired and actual value of the room air temperatures is formed and supplied to the regulator 120 and the controller 127. On the basis of the regulating difference ΔT, the regulator 120 determines a setting value Y_R. Simultaneously with the controller 127, a setting value Ys is determined, which takes on a maximally great value as long as the desired temperature lies above the actual temperature. Of the two setting values Y_S and Y_R, the selection controller 128 selects the smaller one, at this time point the setting value Y_R of the regulator 120, and conducts it onward to the heating device (30). This warms up the air flowing through the air supply channel (10). Therewith, the air supply temperature T_{ZU} rises continuously. From a predetermined temperature threshold value of the air supply, for example $T_{ZU\,SOLL}$ + 5°C, with further rising air supply temperature, the air supply pressure also is increased, since the regulation of the air supply pressure occurs in dependence on the temperature of the air supply. The conveyance volume increases and there takes place a maximally rapid heating-up of all the rooms.

The increased air volume consists not only of fresh air, but a part of the exhaust air again is conducted to the supply air through the environmental air channel 12 in Fig. 1. In this manner, the rooms 1 are sufficiently ventilated and, simultaneously, it is not necessary to heat up much fresh air needlessly.

In the morning heating-up, the fresh air constituent is only--at least--such that the requisite excess pressure is achieved.

When the heating-up process is concluded, usual commercial regulators do not lower the setting value rapidly enough to prevent a rise of the actual temperatures of the rooms I over the desired temperature. For this reason the setting value Y_S of the controller 127 on exceeding of the desired temperature falls to a predetermined minimal value $Y_{S\ MIN}$. Now the minimum selection controller 128 selects the value Y_S of the controller 127 and passes it onward as y' to the heating device 30. Thereupon the air supply temperature again falls, and after a short time the rooms again receive only the minimum fresh air volume that is sufficiently tempered to prevent a lowering of the actual temperature of the air supply below the desired temperature of the air supply. The regulator can therefore slowly reduce its output.

Now there is to be described in addition the case in which only one room has to be heated, while the other rooms have already reached the desired temperature. The selection controller 400 selects the lowest actual temperature of the unheated rooms and passes it on to the block circuit diagram element 100. On the basis of the regulating difference now a setting value y' is set in and the supply air pressure rises correspondingly. So that the rooms will not be supplied with very warm supply air which have already reached the desired temperature, however, the individual room temperature regulation systems 300 regulates the blow-in air

volume of the throttle valves 60, 61 for each room separately. In this manner the throttle valves 60, 61 of the rooms in which the actual temperature are closed to the minimum opening, which ensures that the rooms are sufficiently ventilated. Simultaneously, the throttle valves 60, 61 of the room being heated rising T_{zu} is opened up by the P_{DiFF}, up to 100%, in order to make possible a rapid heating-up. Only when this room has reached its desired temperature does the air-conditioning regulation again set in the minimum ventilation and desired temperature holding state.

It will be apparent to those skilled in the art that various modifications and variations can be made in the air-conditioning apparatus of the present invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this inventions provided they come within the scope of the appended claims and their equivalents.

ABSTRACT

The invention relates to an air-conditioning apparatus which regulates at least the temperature of at least one room to a predetermined temperature desired value ($T_{RAUM\ SOLL}$) by ventilation with heated or cooled supply air. The air-conditioning apparatus has a supply air motor (15) which feeds the supply air through a supply air channel (10) to the room (1) to be air-conditioned, a cooling and/or heating device (30, 40 33) for the cooling or warming of the supply air, and an exhaust air motor (16) which draws the exhaust air from the room (1) to be air-conditioned through an exhaust air channel (11). According to the invention, the desired value ($P_{AB\ SOLL}$) for the regulator of the exhaust air motor (16) forms a room excess pressure established with respect to the outside pressure (P_A).

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SUBSTITUTE SPECIFICATION

I hereby certify that the enclosed substitute specification contains the changes indicated in the enclosed marked-up copy of the original specification and abstract, and that no new matter is included in the substitute specification and abstract.

Respectfully submitted,

William J. Sapone
Registration No. 32,518
Attorney for Applicant(s)

COLEMAN SUDOL SAPONE, P.C.
714 Colorado Avenue
Bridgeport, Connecticut 06605-1601
Telephone No. (203) 366-3560
Facsimile No. (203) 335-6779

AIR-CONDITIONING APPARATUS

FIELD OF INVENTION

The invention relates to an air-conditioning apparatus which regulates the temperature in at least one room by ventilation with heated or cooled air to a predetermined temperature desired value.

BACKGROUND OF THE INVENTION

Air-conditioning apparatuses are used to create in the air-conditioned rooms comfortable conditions of occupation at any time of year, as they hold the temperature and humidity of the room air within fixed limits and provide for a sufficient ventilation with fresh air.

In winter the supply air temperature is higher than the room air temperature when the air is also meant to warm the room, and in summer the supply air is injected at a lower temperature in order to hold the room at the desired cooled room air temperature.

Ordinarily, to achieve this a conventional air-conditioning apparatus circulates too high an amount of air, the temperature of which has been adapted to the heating and cooling requirement. There, it is regarded as disadvantageous that a large volume of air is circulated even after the desired temperature has already been reached. Moreover, the danger exists that the supply air will be blown into the room over the supply air channel and will immediately leave the room to be air-conditioned over the exhaust air channel. There takes place a very small mixing of the new supply air with the air present in the room.

Further, in the air-conditioning of several rooms there is the problem that different desired temperatures are present in the rooms. An adaptation of the temperatures which takes into consideration the comfort in each room is possible only with difficulty.

SUMMARY OF THE INVENTION

Underlying the present invention is the problem of giving an air-conditioning apparatus which operates economically, ensures more comfortable room conditions and an optimal mixing of the room air with the supply air, in order to achieve a rapid adaptation to the heating, cooling, humidifying and dehumidifying desired values.

This problem is solved according to the invention by the means that the air-conditioning apparatus which regulates the temperature in at least one room to a predetermined temperature desired value by ventilation with heated or cooled air. The apparatus is provided with a supply air motor which feeds the supply air over a supply air channel to the room to be air-conditioned, with a cooling and/or heating device introduced into the supply air channel for the cooling or warming of the supply air, and with an exhaust

air motor which draws the exhaust air over an exhaust channel out of the room to be air-conditioned, in which the desired value for the regulator of the exhaust air motor builds up a room excess pressure established with respect to the outside pressure. Further advantageous embodiments of the invention form the objects of the subclaims.

Underlying the invention is the perception that the greater the excess pressure is in a room to be air-conditioned, the better is the ventilation by the supply air blown through the room. Therewith the room warms up faster, the efficiency of the installation is improved and great temperature fluctuations in the room are avoidable for example, very warm at the top and very cool at the bottom, as are also temperature differences over the length and width of the room.

A good flow of air through the room ensures that in the shortest possible time and with a smaller amount of air, a room is heated, cooled, humidified or dehumidified. The smaller amount of supply air blown in is found pleasant. For the faster adaptation of the heating, cooling, humidifying and dehumidifying desired values, the efficiency of the air-conditioning apparatus is improved.

In particular, the desired value for the regulator of the exhaust air motor is determined in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure. This regulating of the exhaust air motor, in dependence on the outside temperature and/or on the supply air temperature and/or on the supply air pressure, is important for the optimization of the air flow. The higher the supply air temperature or the supply air pressure is, the greater the excess pressure would have to be for a favorable flow of air through the room to be air-conditioned with the supply air. The lower, however, the outside temperature is, the higher as a rule, therefore, the excess pressure in the room to be air-conditioned has to be. There must, therefore, be present a greater excess pressure for the ensuring of an optimal flow of air through the room with the blown-in supply air.

On the one hand, preferably the actual value for the regulator of the exhaust air motor is determined by pressure differencethe between the channels, which is calculated from the difference between the absolute value of the pressure in the supply air channel and the absolute value of the pressure in the exhaust air channel. It will then be the case that, for example, excess pressure disturbances will occur in the air-conditioning apparatus in several rooms as a result of opening of windows in individual rooms, and therewith this results in undesired rise of the excess pressure in the other rooms, taking place through the regulation of the exhaust air motor, by reason of the pressure loss in one room.

On the other hand, preferably the actual value for the regulator of the exhaust air motor is formed by the room pressure difference which is calculated from the difference between the outside pressure and the room pressure.

Here above all the room excess pressure varies exclusively over a predetermined temperature range of the outside temperature and/or of the supply air temperature, with change of the outside temperature or of the supply air temperature, in which with an outside

temperature before this temperature range the room excess pressure has in each case a certain constant value and with an outside temperature or supply air temperature after this temperature range the room excess pressure always has a further definite constant value. Above all, with rising outside temperature, in that temperature range the room pressure falls from a maximum excess pressure to a minimal excess pressure.

Thereby account is taken of two opposite demands. On the one hand, for a good flow of air through the room to be air- conditioned it is required that the excess pressure be as high as possible. On the other hand, the excess pressure must not be too great, because it is otherwise felt to be disagreeable, and with too great excess pressure doors open themselves or no longer open can be opened or closed only with high expenditure of force.

So that a comfortable regulation will be accomplished and an excess pressure will be ensured independently from the height or the floor level of the room to be air-conditioned, the room difference pressure is measured at a height or level over 0 (room height). Room height corresponds to outside elevation in respect to sea level.

According to one embodiment of the invention the temperature of the supply air and the channel pressure of the supply air are coupled with one another in such manner that both in dependence on the height of the room temperature to the height of the supply air temperature and also in dependence on the height of the room temperature to the height of the desired value of the room temperature, the channel pressure of the supply air is raised or lowered in the room, rooms or room zones.

The advantages herewith achieved lie especially in that a great volume of air-conditioned air is not unnecessarily circulated, but always only that volume that is required for a maximally rapid adaptation of the actual room values to the predetermined desired values.

In this manner not only are savings in energy achieved, but people in the room find it considerably more agreeable when a relatively strong air movement takes place only when the temperature of the blown-in air deviates from the actual temperature. With conventional air-conditioning apparatuses, in contrast, especially during the morning warming-up phase, even at a room temperature that lies far below the desired value only slightly warmed supply air is blown into the rooms at a high channel pressure. This was hitherto felt to be disagreeable by the persons concerned, but it was regarded as unavoidable.

According to the present embodiment of the invention, heated air with the higher channel pressure is blown into the room only if the temperature of the supply air lies clearly above the predetermined desired temperature of the room and therewith, in the warming-up phase lies far above the actual value of the room. By a relation regulation in which the channel pressure of the supply air is set in a fixed relation to the supply air temperature, a corresponding coupling of channel pressure of the supply air pressure to the supply air temperature can be realized especially advantageously.

Preferably the channel pressure of the supply air into the room, the rooms, or the room zones is adjusted over the line of the supply air motor.

For a selecting arrangement a choice can be made between two delivery volume relations.

In the first place, for the heating case in which the desired value of the room temperature is less than the actual value of the room tcmperature, the channel pressure of the supply air is lowered with rising room temperature. Correspondingly, for the cooling case in which the desired value of the room temperature is greater than the actual value of the room temperature, the channel pressure of the supply air is lowered with falling room temperature. In the second place, for the heating case in which the desired value or the actual value of the room temperature is less than the supply air temperature and the actual value of the room temperature is less than the desired value of the room temperature, the channel pressure of the supply air is raised with rising supply air temperature. Correspondingly, for the cooling case in which the desired value or actual value of the room temperature is greater than the supply air temperature and the actual value of the room temperature is greater than the desired value of the room temperature, the channel pressure is raised with falling supply air temperature. The increase of the channel pressure of the supply air is found to be pleasant. Moreover, the efficiency of the heating and cooling apparatus is improved, as will be stated again further below.

According to a further embodiment of the invention the channel pressure of the supply air varies exclusively over a predetermined temperature range of the supply air temperature. If the supply air temperature presents a height before this temperature range, then the channel pressure of the supply air is allocated in each case to a certain constant magnitude. If the supply air temperature presents a height after the temperature range, then the channel pressure of the supply air is allocated in each case to a further determined constant magnitude.

In particular, with a supply air temperature higher with respect to the room temperature, the channel pressure rises over the predetermined temperature range of the channel pressure from its minimum performance up to its maximum performance with rising supply air temperature, and it correspondingly falls with falling supply air temperature.

Through the two regulating systems of the supply air channel pressure behavior, on the one hand it is made possible for the efficiency of the air-conditioning apparatus to be improved. With higher channel pressure of the supply air there is achieved also a more rapid and better flow through the room, and therewith a faster heating up of the rooms. On the other hand, for reasons of comfort, too great an air flow should be avoided, since this is felt to be disagreeable. The opposite demands are now optimally satisfied.

Here the regulating circuit which regulates the channel pressure of the supply air is subordinated to the temperature regulating circuit; the desired supply channel pressure value being set in a fixed relation to the actual value of the supply air temperature. Herewith there

is avoided any excessive increasing or decreasing in the temperature regulation. The room temperature swings back faster to the desired value temperature.

With air-conditioning for several rooms, the heated supply air is made available over a common supply air channel. In the case of different desired and actual temperatures of all the rooms, however, each room has a different heating requirement. In order to take this circumstance into account, according to a further form of execution of the invention, in the simultaneous air-conditioning of several rooms or room zones, the individual rooms or room zones are connected in each case over a supply air, and an exhaust air line allocated to them to the central supply air and exhaust air channel, and in the individual supply air and/or exhaust air lines throttle clack valves are arranged over which the channel pressure of the supply air is adjusted in the room, the rooms or room zones.

Thereby undesired air movements are avoided in rooms, the actual and desired values of which are alike or approximately alike. Moreover it is achieved that, for example, in the case of a fully open fresh air clack valve, an excessive amount of fresh air is not worked up.

The regulation of the clack valves can occur additionally in dependence on supply air pressure or on the turning rate of the supply air motor.

In such an independent regulation of supply air temperature and individual room temperature, a situation can arise in which a single room has to be heated as rapidly as possible, but other rooms that already lie at their desired temperature are to be heated up as little as possible. When the supply air temperature rises, the individual regulation of these warm rooms will tend to close the clack valves. Therewith, however, these rooms and the persons present in them are cut off from the fresh air supply.

This problem is advantageously solved according to a further embodiment, in which at a supply air temperature that lies above the desired temperature, in rooms the actual temperature of which corresponds to the desired temperature, the requisite minimum volume of fresh air also is blown. In this manner it is achieved that these rooms are supplied with sufficient fresh air; nevertheless, a possible warming of the rooms by reason of a supply air temperature that lies above the desired temperature is avoided insofar as possible. The minimal opening required for the prescribed minimum fresh air volume depends on the supply air temperature and on the fresh air component of the supply air, for the fresh air component of the supply air is reduced if possible warming-up phase in the morning for a maximally rapid heating up and replaced by return air.

According to one embodiment, the exhaust air channel and the supply air channel are connected with one another over a return air channel, in which case at least one air exhaust throttle clack valve is provided in the return air channel, and at least one fresh air throttle clack valve is provided in the fresh air channel engaged ahead of the supply air channel.

According to a further embodiment the minimum cross section of the throttle clack valves is adjusted in dependence on the opening of the fresh air throttle clack valve, of the

exhaust air throttle clack valve and of the mixing air throttle clack valve, so that in each regulation situation there is ensured the minimum amount of fresh air.

With regulated channel pressure for the supply air and for the exhaust air, the opening positions of the throttle clack valves allocated relative to one another in a room or in a room zone are equal.

Analogously to the heating regulation, there can also take place a cooling regulation.

For the temperature regulation, regulators are used. In practice, these regulators tend to an overswinging and underswinging of the regulating magnitude.

According to a further embodiment of the invention, in each case the setting value of at least one regulator, especially of the temperature regulator, is connected to a subordinated switching arrangement, and the switching arrangement, in the case of an overswinging (exceeding) of the regulating magnitude, selects a value predetermined for it, as the setting magnitude, which clearly lies under the value chosen simultaneously by the regulator.

Such a behavior can advantageously be obtained by an additional control arrangement and a minimum-selection arrangement. This additional control arrangement delivers, in dependence on the regulating difference, a predetermined minimal value for the setting magnitude when an overswinging of the regulating magnitude occurs, and a predetermined maximal value for the setting magnitude when the actual value of the temperature (the regulating magnitude) lies below the desired value. The minimum selection arrangement then in each case selects the minimum, from the values made available by the regulator and the additional control arrangement, and forwards the selected value as setting magnitude. In this manner the additional control arrangements always takes over the control of the setting magnitude when by reason of the setting magnitude of the regulator an overswinging (exceeding) occurs in the regulating magnitude.

According to a further embodiment of the invention there are provided a fresh air clack valve in a fresh air channel engaged on inlet side of the supply air channel, a mixed air clack valve in a return air channel connecting the supply air channel with the exhaust air channel, and a discharge air clack valve in a discharge air channel connecting to the exhaust air channel, in which situation the settings of the fresh air clack valve, of the discharge air clack valve and of the mixed air clack valve are regulated in common dependence on the turning rate of the supply air motor or on the channel pressure of the supply air, and in which up to a certain minimal opening for the ensuring of a fresh air minimum, with increasing turning rate of the supply air motor and/or with rising channel pressure of the supply air, the opening cross sections of the fresh air clack valve and of the discharge air clack valve can be reduced and the opening cross section of the mixed air clack valve can be increased.

The opening position of the fresh air clack valve and the opening position of the exhaust air clack valve are always of equal size. The opening position of the mixed air clack valve is always the difference of the opening position or the fresh air or exhaust air clack

valve to 100%, for example, if the opening positions of the fresh air clack valve and exhaust air throttle clack valve are each case 70%, then the opening position of the mixed air clack valve is 30%. If the mixed air clack valve has an opening position of 70%, then the opening positions of the fresh air and exhaust air clack valves are in each case 30%.

In a further preferred embodiment of the invention, more than one room is air-conditioned from a central installation. In the case of different heating requirements for the individual rooms, it is also necessary to make available over the supply air a sufficient heating capacity for all the rooms. This can be achieved inter alia by the means that the heating required is measured in accordance to the actual temperature of the coldest room, in order to bring also this room to the desired temperature in a short time. Accordingly, in one form of execution of the invention, in the simultaneous air-conditioning of several rooms the actual temperature of each room is fed to a central regulating arrangement, and a temperature value to be determined individually from these individual actual values is supplied as actual value for the heating regulator.

According to a further embodiment of the invention, a moistening arrangement is provided which humidifies the supply air in the supply air channel, in which process the humidifying arrangement is regulated both in dependence on the room moisture or the exhaust air moisture as well in dependence on the supply air temperature.

According to a further embodiment of the invention, there are provided a first heating device installed in the supply air channel, a cooling device engaged after the first heating device in the supply air channel, and a second heating device installed after the cooling device in the supply air channel for the heating, cooling and dehumidifying of the supply air, the second heating device being regulated for the desired value moisture in dependence on the actual value moisture.

In particular with a rising actual value humidity which already lies above the desired value humidity, the heating performance of the second heating device rises.

The heating performance of the second heating device is regulated either with a regulator or it climbs with rising actual value moisture over a predetermined moisture range of the room moisture; at a room moisture content before this moisture range the heating performance has in each case a certain constant magnitude and at a room moisture after the moisture range the heating performance has in each case a further determined constant magnitude.

It is hereby achieved that a dehumidifying is brought about over raising of the room temperatures insofar as the actual value of the room temperature remains under the limit value from which the cooling process is initiated. Cooling starts only when the actual value of the room temperature is greater than the desired value of the room temperature plus the temperature displacement dependent on the outside temperature. By the heating-up, and therewith the dehumidifying of the room over the rising temperature, the room is dehumidified rapidly and with a relatively low expenditure of energy.

The channel pressure of the supply air is not raised during the dehumidifying process.

In order to guarantee a minimum amount of fresh air in the room or the rooms, the regulation of the fresh air clack valve and of the discharge air clack valve occurs in dependence on the opening position of the mixed air clack valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings, which are included to provide further understanding of the present invention and are incorporated in and constitute a part of this specification, illustrate the preferred embodiments of the invention and together with the description serve to explain the principles of the invention.

In the simplest case, a single room is tempered and ventilated with the air-conditioning apparatus. The regulation of a multi-room air-conditioning is described in the example of execution with the aid of the drawing, in which:

Fig. 1 shows a schematic representation of the air circulation in an air-conditioning apparatus according to the invention.

Fig. 2 is a block circuit diagram with the most important elements of the regulating and control arrangements of the example of execution.

Fig. 3 is a block circuit diagram with important elements of the temperature regulating circuit from Fig. 2.

Fig. 4 is a block circuit diagram of the conveyance volume regulating circuit of the supply air from Fig. 2.

Fig. 5 is a block circuit diagram of the individual temperature regulating circuit for each room from Fig. 2.

Fig. 6a shows the relation between the supply air temperature and the supply air pressure for the example of execution when the room actual temperature is less than the desired value-room temperature.

Fig. 6b shows the relation between the room temperature and the supply air pressure for the example of execution when the actual vacuum room temperature is greater than or equal to the desired value room temperature.

Fig. 7 is a block circuit diagram of the temperature regulator of the example of execution.

Fig. 8a is a block circuit diagram of the regulator of the exhaust air motor of the example of execution.

Fig. 8b is the block circuit diagram with the most important elements from Fig. 8a.

Fig. 8c shows the relation between the desired value of the room difference pressure for the regulator of the exhaust air motor.

Fig. 9 shows the relation between the room exhaust air moisture and the setting magnitude for the after-heater.

Fig. 10 is a run-off diagram with the most important block circuit diagram elements participating in the heating-up process.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1 there is schematically represented the air circulation of a multi-room air-conditioning system. From the rooms 1 to be air-conditioned there lead, on the one hand, supply air lines 5 to a supply air channel 10 and, on the other hand, exhaust air lines 6 to an exhaust air channel 11.

In the supply air line 5 there is arranged in each case a throttle clack valve 60 and in the exhaust air line 6 in each case a throttle clack valve 61.

The supply air channel 10 and the exhaust air channel 11 are connected with one another over a return air channel 12.

On inlet side of the supply air channel 10 there is engaged a fresh air channel 20 and on the outlet side of the exhaust air channel 11 there is engaged an exhaust air channel 21.

In the fresh air channel 20 there is provided a fresh air throttle clack valve 70, in the return air channel 12 a mixed air throttle clack valve 72 and in the exhaust air channel 21 an exhaust air throttle clack valve 71.

In the supply air channel 10 there are arranged successively in flow direction of the air a first heating device 30, a cooling device 40, a second heating device 33, a supply air motor 15 and humidifying device 50.

In the supply air channel there is generated by the supply air motor 15 an air pressure P_{ZU} which provides that the supply air is blown with sufficient conveyance volume into the rooms 1 to be air-conditioned.

Correspondingly in the exhaust air channel 11 re is generated by the exhaust air motor 16 a subpressure P_{AB}, which draws off the room air.

In the simplest case, the pure airing case (office operation) the drawn off room air (= the exhaust air) is given off over the exhaust air channel 11 and the exhaust air channel 21 to the outer atmosphere, and over the fresh air channel 20 the required supply air is drawn as fresh air into the supply air channel 10. For this the fresh air throttle clack valve

70 and the exhaust throttle air clack valve 71 are opened and the mixed air throttle air clack valve 72 is closed. The fresh air throttle clack valve 70 and the exhaust air throttle clack valve 71, there, always have equal opening settings.

In order to make possible a warming-up of the air-conditioned rooms 1, the drawn-in fresh air flows through the first heating device 30 (preheater) over which drawn-in air is brought according to heating requirement to the requisite supply air temperature T_{ZU}. After passing the disengaged cooling device 40 and the second heating device 33 (afterheater) it is fed to the humidifying arrangement 50, which supplies the necessary moisture to the air.

Instead of the first heating device 30, in a required cooling of the rooms to be air-conditioned the cooling device 40 is in operation. In the case of excessive humidity, instead of the moistening device 50 the afterheater 33 is in operation for the dehumidifying. In order to ensure a more rapid heating-up, both the first heating device 30 and also the second heating device 33 can be in operation. This, however is possible for the heating case, not for the dehumidifying case.

The air worked-up in this way is fed to the individual rooms to be air-conditioned, over the supply air motor 15, the supply air channel 10 and the supply air lines 5 with the throttle clack valves 60. The volume of the air blown-in and drawn off from each individual room can be regulated by the throttle clack valves 60, 61 arranged in the supply air lines 5 and in the exhaust air lines 6 individually.

In the case of increased heat requirement, for example in the morning warm-up phase, it is advantageous to supply the rooms not only with drawn-in fresh air, but to use a part of the drawn-off room air repeatedly, for in the simultaneous warming-up and ventilation the required supply air volume lies far over the fresh air minimum volume. For this reason, in dependence on the supply air temperature T_{ZU} over a control arrangement 500 in Fig. 2 a setting value Yv is calculated and supplied to the air throttle clack valves 550 in Fig. 2, or 70, 71, 72 in Fig. 1.

While the fresh air throttle clack valve 70 and the exhaust air throttle clack valve 71 receive the same control signal, the mixed air throttle clack valve 72 in the return air channel 12, there, is supplied the exactly opposite control signal. The open position of the mixed air throttle clack valve 72 is always the difference between the open position of the fresh air clack valve 70 or of the exhaust air clack valve 71 and 100%. For example the open position of the fresh air clack valve 70 and of the exhaust air clack valve 71 amounts in each case to 70%, then the open position of the mixed air clack valve 30 amounts to 30%. If the mixed air clack valve has an open position of 70%, then the open position of the fresh air clack valve 70 and of the exhaust air clack valve 71 is in each case 30%.

In this manner it is possible again to feed a certain proportion of the drawn-off room air over the return air channel 12 to the supply air. Simultaneously over the fresh air channel 20 and the fresh air clack valve 70 a corresponding fresh air component is supplied to the supply air. This fresh air component amounts in the example of execution in the

airing case (during the office hours) to up to 100%. During office hours, therefore, the mixed air clack valve 72 as a rule is not opened, (and) the fresh air clack valve 70 and the exhaust air clack valve 71 are normally opened to 100% each. With increased heating requirement and a maximal supply air pressure $P_{ZU\ MAX}$ the fresh air component falls to approximately 10%—warming-up phase in the morning.

In the air-conditioning, from the measured room temperatures $T_{RAUM\ IST1}$, $T_{RAUM\ IST2}$ or $T_{RAUM\ IST\ N}$ in the minimal selection arrangement 400 in Fig. 2, the lowest value $T_{RAUM\ IST\ MIN}$ is determined and used for the calculation of the heating requirement. For this the actual temperature $T_{RAUM\ IST\ MIN}$ in the block circuit diagram element 100 is subtracted from the predetermined (maximal) desired temperature $T_{RAUM\ SOLL}$ (of all the rooms). On the basis of the temperature difference T (regulating difference), by the temperature regulation 130 there is determined a suitable desired value y' for the heating valve 170 of the heating device 30 in Fig. 1.

The setting value Yr calculated in Fig. 3 for the temperature regulation is monitored by the circuited arrangement 125 arranged on outlet side in order largely to prevent an overswinging of the temperature usual with conventional regulators. In the normal case, as long as $T_{RAUM\ IS\ MIN}$ lies below $T_{RAUM\ SOLL}$, the arrangement 125 forwards the setting value Y_R unaltered as y' onward to the heating valve 170. If, however, $T_{RAUM\ IST\ MIN}$ exceeds the desired temperature $T_{RAUM\ SOLL}$ then, instead of Y_R a much smaller setting value y' will be forwarded on to the heating valve 170. The value of the setting magnitude y' assures in this case the minimally required supply air temperature $T_{ZU\ MIN}$, which is dependent on the outside temperature T_A. In this manner with the example of execution there is achieved a maximal overswinging of the desired temperature by only 0.3 °C; a falling below this virtually does not take place.

The monitoring of the setting signal Y_R of the regulator 120 is executed in the example of execution by a switching arrangement 127 in Fig. 7 and a minimum selection arrangement 128. The control arrangement simultaneously generates for the regulator 120 a setting signal Y_S which takes on a maximally great value as long as the desired temperature $T_{RAUM\ SOLL}$ lies above the actual temperature $T_{RAUM\ IST}$ and down to the very low setting $Y_{S\ MIN}$ as soon as the actual temperature exceeds the desired value.

The setting value $Y_{S\ MIN}$ of the control arrangement 128 is adjusted by the computing arrangement 129 for the cutting-off of the otherwise occurring underswinging of the temperature regulation in dependence on the outside temperature T_A with which the fresh air is drawn in.

The minimum selection arrangement 128 in each case selects, from the two setting value signals Y_R and Y_S at its disposal, the smaller one and forwards this onward as y' to the heating valve 170. In this manner there is prevented insofar as possible an overswinging of the temperature to be regulated.

In dependence on the temperature of the supply air the conveyance of the supply air motor 15 is adjusted over the generated supply air pressure P_{ZU}. For this first of all, in a

$P_{ZU\ SOLL}$ value calculating arrangement 200 shown in Fig. 2, there is determined a desired value $P_{ZU\ SOLL}$ for the supply air pressure. The relation between the supply air temperature T_{ZU} and the supply air pressure $P_{ZU\ SOLL}$ is given in Fig. 6a, and, namely, for the case in which the room temperature $T_{RAUM\ IST}$ is less than the desired value of the room temperature $T_{RAUM\ SOLL}$.

Only when the supply air temperature lies clearly above the desired value temperature, in the example of execution by 5 °C, is the desired pressure of the supply air increased. When this supply air temperature is below this threshold only the volume of air necessary for the ventilation of the rooms is blown into the air-conditioned rooms.

The relation between the room temperature $T_{RAUM\ IST}$ and the desired value of the supply air pressure $P_{ZU\ SOLL}$ is represented in Fig. 6b and, namely, for the case in which the room temperature TRAUM IST is greater than the desired value of the room temperature $T_{RAUM\ SOLL}$, or is equal to the desired value for the supply air temperature $T_{RAUM\ SOLL}$.

With increasing actual room temperature $T_{RAUM\ IST}$, when the room temperature is higher than the desired room temperature value $T_{RAUM\ SOLL}$, the air supply temperature T_{ZU} falls and the supply airpressure P_{ZU} falls from its maximal pressure $P_{ZU\ SOLL\ MAX}$ to its minimal pressure $P_{ZU\ SOLL\ MIN}$.

The desired supply air pressure $P_{ZU\ SOLL}$ determined by the $P_{ZU\ SOLL}$ value calculating arrangement 200 in Fig. 2 is compared in the block circuit diagram element 230 with supply air actual pressure

$P_{ZU\ IST}$. The pressure difference P is supplied to the pressure regulation 250.

The complete pressure regulating circuit is represented in Fig. 4. The regulating difference ΔP is fed to the regulator 240, which sets-in the setting magnitude Y_P. A limit value switch 245 monitors the setting value Y_P, so that a predetermined minimum pressure $P_{ZU\ MIN}$ which corresponds to a predetermined minimum ventilation volume is not gone below. The setting value Y_P of the limit value switch 245 controls the ventilator 285 in Fig. 4 or 15 in Fig. 1, which generates the pressure of the regulating stretch 286.

With the corresponding regulating circuit by an exhaust air motor 16 in the exhaust air channel 11 a subpressure P_{AB} is generated which, for the maintaining of a predetermined excess pressure in the rooms, draws off a corresponding volume of air. The regulation of the exhaust air motor 16 will still be further described below.

The tempered supply air in the supply air channel 10 is available over the supply air lines 5 for the ventilating and heating-up of all the rooms 1. With the aid of the throttle clack valves 60, 61, the volume of the air blown in or drawn off in each room is adapted to the particular actual heating requirement. For this in each case there are used the desired temperature, the actual temperature, the supply air temperature and the minimum ventilation volume for the setting of the throttle valves. This regulating circuit, represented in Fig. 2 as a block circuit forming element 300, is reproduced in Fig. 5.

In the block circuit element 310 the individual desired temperature $T_{SOL\ N}$ is compared with the corresponding actual temperature $T_{IST\ N}$; the regulating difference T_N ascertained there is supplied to the regulator 320. On the basis of the temperature difference, ΔT_N, of the supply air temperature T_{ZU} and of the supply air pressure P_{ZU}, this generates a setting signal Y_T which must not fall below a minimal value which is yielded from the actual supply air pressure P_{ZU} and from the minimal pressure $P_{ZU\ MIN}$. The setting signal $Y_{T\ N}$ is fed to the throttle clack valves 330 in Fig. 5, and 60, 61 in Fig. 1. The regulating stretch of this individual temperature regulating circuit is represented by the block circuit element 340.

The throttle valves 60, 61 are regulated, therefore, in dependence on the temperature desired value $T_{RAUM\ SOLL}$ in each room individually, on the temperature actual value $T_{RAUM\ IST}$ measured in each individual room, of the temperature value of the supply air temperature T_{ZU}, as well as in dependence on the supply air pressure P_{ZU} and/or the turning rate of the supply air motor.

As stated above, the regulating circuit ensures, for the adjustment of the opening cross section of the throttle valves 60, 61, a certain minimum opening cross section yielded in dependence on the supply air pressure, which cross section is not gone below in the adjustment of the throttle valves 60, 61. This minimum opening cross section is adjusted there in such manner that each room receives a predetermined absolute minimum fresh air volume.

The minimum opening cross section of the throttle valves 60, 61 is likewise adjusted in dependence on the opening of the fresh air clack valve 70 of the exhaust air clack valve 71 and of the mixed air clack valve 72.

With regulated conveyance volume of the supply air and of the exhaust air the opening settings of the throttle clack valves 60, 61 allocated to one another in a room 1 are equal.

In the regulating of the exhaust air motor 785 according to Fig. 8b, or 16 according to Fig. 1, the desired value for the exhaust air motor is calculated on dependence on the outside temperature in the $P_{DIFF\ SOLL}$ value calculating arrangement 710, in which operation this desired value forms a room excess pressure $P_{DIFF\ SOLL}$ established in respect to the outside pressure P_A in dependence on the outside temperature. The desired value $P_{AB\ SOLL}$ can also be determined in dependence on the supply air temperature and/or on the supply air pressure.

The relation between the outside temperature T_A and the desired value for the exhaust air motor / = desired value for the room excess pressure $P_{DIFF\ SOLL}$, which is yielded from the difference between the desired value of the exhaust air pressure $P_{AB\ SOLL}$ and the outside pressure P_A is represented in Fig. 8c. If the outside temperature T_A exceeds a certain limit value, for example an outside temperature of -10 ^{o}C, the desired value $P_{DIFF\ SOLL}$ of the exhaust air motor falls with rising outside temperature from its maximum $P_{DIFF\ SOLL\ MAX}$ to its minimum $P_{DIFF\ SOLL\ MIN}$ with a further limit value, for example with an outside temperature of +15 ^{o}C. At an outside temperature before or after this temperature range

established by the two limit values, the desired value of the exhaust air motor $P_{DIFF\ SOLL}$ corresponds either to the maximal room difference pressure $D_{DIFF\ SOLL\ MAX}$ or to the minimal room difference pressure $P_{DIFF\ SOLL\ MIN}$.

The desired value of the exhaust air motor $P_{DIFF\ SOLL}$ determined by the value calculating arrangement 710 in Fig. 8a is compared in the block circuit diagram 700 with the room difference actual pressure value $P_{DIFF\ IST}$ in one room and in several rooms with the supply air and exhaust air channel pressure differential. The pressure difference ΔP is fed the pressure regulation 730.

The complete pressure regulating circuit is presented in Fig. 8b. The regulating difference ΔP_{DIFF} is fed to the regulator 740, which adjusts the setting magnitude $Y_{P\ DIFF}$. If in a large room office several windows are open, the exhaust fan can be shut off entirely--only in this way is it possible to maintain a slight excess pressure. With the setting value $Y_{P\ DIFF}$ of the regulator 740 the exhaust air motor 785 in Fig. 8b, or 16 in Fig. 1 which generates the pressure of the regulating stretch 786 is controlled.

The actual value for the regulator 740 of the exhaust air motor 16 or 785 is formed by the actual room difference pressure $P_{DIFF\ IST}$, which is yielded from the difference between the outside pressure P_A and the room pressure $P_{RAUM\ IST} = P_{AB\ IST}$. The room difference pressure $P_{DIFF\ IST}$ is measured there at a level above 0 (sea level).

The form of execution described can be used analogously for the cooling.

In an additional regulating circuit, the air humidity in the air-conditioned rooms is regulated. It is measured preferably as relative air moisture (in percent of the vapor pressure at full saturation) and expressed by a simplified designation F in the following. It is entirely possible, however, to use instead of the relatively humidity the absolute humidity (g of water vapor per m3 of air), the vapor pressure, the specific moisture (in g H2O per kg of moist air) or as mixture ratio (in g H_2O per kg of dry air). With use of the relative humidity, the dependence on the saturation limit is advantageously integrated into the value. According to the VDI ventilation rules, air humidity should amount in winter, at 20 ^{o}C room temperature, to 35% to 70% relative air humidity, and, in summer, at 22 ^{o}C air temperature, to 70%, and at 25 ^{o}C, to 60%.

In the block circuit element 600 in Fig. 1, there is determined the difference between the desired air moisture $F_{AB\ SOLL}$ and actual air moisture $F_{AB\ IST}$, in which representationally for the air moisture in the individual rooms in the example of execution, the moisture of the exhaust air F_{AB} is measured and adjusted. The determined moisture difference ΔF_{AB} is first introduced into a limit value circuit device 610, which on the basis of predetermined minimal and maximal moisture F_{AB} MIN and $F_{AB\ MIN}$, in dependence on the supply and exhaust air temperature, prevents the saturation limit from being exceeded in any place in the air circulation. From this limit value switching device 610, a corrected regulating difference $\Delta F_{AB'}$ is now led to the regulator 620, which controls the air moistener 630 over the control signal Y_L. Thereby, the moisture of the supply air F_{ZU} is adjusted. The regulating stretch is represented by the block circuit diagram element 640.

The second heating device 33, in the heating case, may also contain the signal Y' of the first heating device 30. The second heating device (33) serves, however, as an after-heater essentially for the dehumidifying. This second heating device (33) is regulated in dependence on the actual value moisture F_{IST} for the desired value moisture, in which with rising actual value moisture F_{IST} over the desired value moisture F_{SOLL} the heating performance of the second heating device (33) rises. The rise of the heating performancc of the second heating device (33) moves over a predetermined moisture range of the room moisture F_{IST}. This relation is represented in Fig. 9. At a room moisture F_{IST} before this moisture range, the second heating device (33) is not in operation.

At a room moisture F_{IST} after this moisture range, the second heating device (33)—the after-heater—is in operation with its maximal performance.

By a control arrangement (not represented here) it is made certain that the conveyance volume of the supply air is not increased during the dehumidifying process and that only a minimum amount of fresh air is blown in.

For a better illustration of the regulating system, in the following there is described, by way of example, a warming-up process such as ordinarily takes place in the morning. The block circuit diagram elements participating in the run-off of the regulation are represented in Fig. 10. At the time point when the switching-on of the air-conditioning apparatus takes place, the actual temperatures of all the rooms 1 and the temperature of the drawn-in fresh air lie far above the desired temperature for the rooms 1. Since the temperature of the supply air is still very low, no more supply air is blown into the rooms. For this, a minimal air pressure $P_{ZU\ MIN}$, corresponding to the minimum of fresh air volume, is generated.

At a lower outside temperature below 16 C, the regulator is prior-occupied at the start with a value according to the outside temperature, so that the installation will show no frost disturbance in the starting.

From the actual temperatures of all the rooms 1 to be air-conditioned, the minimum-selection arrangement 400 selects the lowest value and conducts this to the block circuit diagram element 100. Here the regulating difference ΔT between the desired and actual value of the room air temperatures is formed and supplied to the regulator 120 and the control arrangement 127. On the basis of the regulating difference ΔT, the regulator 120 determines a setting value Y_R. Simultaneously with the control arrangement 127, a setting value Y_S is determined, which takes on a maximally great value as long as the desired temperature lies above the actual temperature. Of the two setting values Y_S and Y_R, the minimum selection arrangement 128 selects the smaller one, at this time point the setting value Y_R of the regulator 120, and conducts it onward to the heating device (30). This warms up the air flowing through the air supply channel (10). Therewith, the air supply temperature T_{ZU} rises continuously. From a predetermined temperature threshold value of the air supply, for example $T_{ZU\ SOLL} + 5\ ^{o}C$, with further rising air supply temperature, the air supply pressure also is increased, since the regulation of the air supply pressure occurs in

dependence on the temperature of the air supply. The conveyance volume increases and there takes place a maximally rapid heating-up of all the rooms.

The increased air volume consists not only of fresh air, but a part of the exhaust air again is conducted to the supply air over the environmental air channel 12 in Fig. 1. In this manner, the rooms 1 are sufficiently ventilated and, simultaneously, it is not necessary to heat up much fresh air needlessly.

In the morning heating-up, the fresh air constituent is only—at least—such that the requisite excess pressure is achieved.

When the heating-up process is concluded, usual commercial regulators do not lower the setting value rapidly enough to prevent a rise of the actual temperatures of the rooms 1 over the desired temperature. For this reason the setting value Y_S of the control arrangement 127 on exceeding of the desired temperature falls to a predetermined minimal value $Y_{S\ MIN}$. Now the minimum selection arrangement 128 selects the value Y_S of the control arrangement 127 and passes it onward as y' to the heating device 30. Thereupon the air supply temperature again falls, and after a short time the rooms again receive only the minimum fresh air volume that is sufficiently tempered to prevent a lowering of the actual temperature of the air supply below the desired temperature of the air supply. The regulator can therefore slowly reduce its output.

Now there is to be described in addition the case in which only one room has to be heated, while the other rooms have already reached the desired temperature. The selection arrangement 400 selects the lowest actual temperature of the unheated rooms and passes it on to the block circuit diagram element 100. On the basis of the regulating difference now a setting value y' is set in and the supply air pressure rises correspondingly. So that the rooms will not be supplied with very warm supply air which have already reached the desired temperature, however, the individual room temperature regulation 3000 regulates the blow-in air volume of the throttle clack valves 60, 61 for each room separately.. In this manner the throttle valves 60, 61 of the rooms in which the actual temperature are closed to the minimum opening, which ensures that the rooms are sufficiently ventilated. Simultaneously, the throttle valves 60, 61 of the room being heated rising Tzu is opened up by the P_{DIFF}, up to 100%, in order to make possible a rapid heating-up. Only when this room has reached its desired temperature does the air-conditioning regulation again set in the minimum ventilation and desired temperature holding state.

It will be apparent to those skilled in the art that various modifications and variations can be made in the air-conditioning apparatus of the present invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this inventions provided they come within the scope of the appended claims and their equivalents.

CLAIMS:

1. An air-conditioning apparatus for controlling condition, for example, temperature, in at least one room to a predetermined temperature desired value by ventilation with heated or cooled supply air, comprising:

a supply air motor which provides the supply air over a supply air channel to the room to be air-conditioned;

a cooling and/or heating device for cooling or warming of the supply air;

an exhaust air motor, which draws exhausted air over an exhaust air channel out of the room to be air-conditioned, and

a regulator of the exhaust air motor for forming a room excess pressure with respect to the outside pressure

2. The air-conditioning apparatus according to claim 1, wherein a desired value for the regulator of the exhaust air motor is determined by outside temperature and/or supply air temperature and/or supply air pressure.

3. The air-conditioning apparatus according to claim 2, wherein the actual value for the regulator of the exhaust air motor is formed by a channel pressure differential calculated from a difference between an absolute value of the pressure in the supply air channel and an absolute value of the pressure in the exhaust air channel.

4. The air-conditioning apparatus according to claim 2, wherein the actual value for the regulator of the exhaust air motor is formed by the room pressure differential which is yielded from the difference between the outside pressure and the room pressure

5. The air-conditioning apparatus according to claims 3, wherein the room excess pressure changes exclusively over a predetermined temperature range of the outside temperature and/or of the supply air temperature with change of the outside temperature or of the supply air temperature, in which with an outside temperature or supply air temperature before this temperature range the room excess pressure has in each case a certain constant magnitude and with an outside temperature after this temperature range the room excess pressure has in each case a further determined constant magnitude.

6. The air-conditioning apparatus according to claims 5, wherein within the temperature range the room pressure falls with rising outside temperature from a maximal excess pressure to a minimal excess pressure.

7. The air-conditioning apparatus according to claim 6, wherein the room pressure differential is measured at a level above 0, where room height corresponds to outside height in respect to sea level.

8. The air-conditioning apparatus according to claim 7, wherein the temperature of the supply air and the channel pressure of the supply air are coupled with one another in such manner that both in dependence on the level of the room temperature to the levcl of the room air supply temperature, and also in dependence on the level of the room temperature

to the level of the desired value of the room temperature the channel pressure of the supply air into the room, the rooms or room zones is raised or lowered.

9. The air-conditioning apparatus according to claim 8, wherein the channel pressure of the supply air into the room, the rooms or room zones is adjusted over the performance of the supply air motor.

10. The air-conditioning apparatus according to claim 9, wherein in case when the desired value of the room temperature is less than the actual value of the room temperature, the channel pressure of the supply air is lowered with rising room temperature.

11. The air-conditioning apparatus according to claim 10, wherein in case when the desired value of the room temperature is greater than the actual value of the room temperature the channel pressure of the supply air is reduced with falling room temperature.

12. The air-conditioning apparatus according to claim 11, wherein in case when the desired value or actual value of the temperature is less than the supply air temperature and the actual value of the room temperature is less than the desired value of the room temperature, the channel pressure is raised with rising supply air temperature.

13. The air-conditioning apparatus according to claim 12, wherein in case when the desired value or actual value of the room temperature is greater than the supply air temperature and the actual value of the room temperature is greater than the desired value of the room temperature, the channel pressure is increased with falling supply air temperature.

14. The air-conditioning apparatus according to claim 13, wherein the channel pressure of the supply air varies exclusively over a predetermined temperature range of the supply air temperature, with a supply air temperature before this temperature range the channel pressure of the supply air always has a certain constant magnitude and with a supply air temperature after the temperature range the channel pressure of the supply air always has a further determined constant magnitude.

15. The air-conditioning apparatus according to claim 11, wherein with a supply air temperature higher with respect to the room temperature, over a certain temperature range the channel pressure of the supply air increases from its minimum performance up to its maximum performance with rising supply air temperature and with decreasing supply air temperature it falls correspondingly.

16. The air-conditioning apparatus according to claim 9, including the regulating circuit which regulates the channel pressure of the supply air, said circuit is connected to the temperature regulating circuit, the channel pressure desired-value guide magnitude of the conveyance volume circuit being settable in a fixed relation to the supply air temperature actual value.

17. The air-conditioning apparatus according to claim 16, wherein in simultaneous air-conditioning of several rooms or room zones the individual rooms or room zones in each

case are connected, over a supply-air and exhaust-air lines to the central supply-air and exhaust-air channels and that in the individual supply-air and/or exhaust air lines there are arranged throttle clack valves over which the channel pressure of the supply air into the room, rooms or room zones is adjusted.

18. The air-conditioning apparatus according to claim 17, wherein the throttle clack valves are settable in dependence on the channel pressure of the supply air or the turning rate of the supply air motor.

19. The air-conditioning apparatus according to claim 18, wherein a regulating circuit for the setting-in of the opening cross section of the throttle clack valves does not go below a minimum opening cross section yielded in dependence on the channel pressure of the supply air in the adjustment of the throttle clack valves, and the regulating circuit sets in this minimal opening cross section in such manner that each room receives a predetermined absolute minimum fresh volume.

20. The air-conditioning apparatus according to claim 17, wherein the exhaust air channel and the supply air channel are connected with one another over a return air channel, there being provided at least one exhaust air clack valve in the exhaust air channel connecting to the exhaust air channel, at least one mixed air clack valve in the return air channel, and at least one fresh air clack valve in the fresh air channel engaged before the supply air channel.

21. The air-conditioning apparatus according to claim 20, wherein the minimum opening cross section of the throttle clack valves is adjusted in dependence on the opening of the fresh air clack valve, the exhaust air clack valve, and the mixed air clack valve.

22. The air-conditioning apparatus according to claim 21, wherein with regulated conveyance volume of the supply air and of the exhaust air the opening settings of the throttle clack valves in a room or a room zone are equal.

23. The air-conditioning apparatus according to claim 22, wherein the setting magnitude of at least one regulator, especially of the temperature regulator, is connected to a switching arrangement on outlet side, and the switching arrangement on an overswinging of the regulating magnitude selects a value predetermined for it for the setting magnitude which lies below the value simultaneously selected by the regulator.

24. The air-conditioning apparatus according to claim 23, including a fresh air clack valve in a fresh air channel engaged before the supply air channel, a mixed air clack valve in a return air channel connecting the supply air channel with the exhaust air channel, and a discharge air clack valve in a discharge air channel connected to the exhaust air channel, in which the settings of the fresh air clack valve, of the discharge air clack valve and of the mixed air clack valve are regulated in common in dependence on the turning rate of the supply air motor or on the channel pressure of the supply air, and in which up to a certain minimum opening for the ensuring of a fresh air minimum with increasing turning rate of the supply air motor and/or with increasing channel pressure of the supply air, the

opening cross sections of the fresh air clack valve and of the exhaust-air clack valve are reduced and the opening cross section of the mixed air clack valve is increased.

25. The air-conditioning apparatus according to claim 24, wherein for simultaneous air-conditioning of several rooms the actual temperature of each room is fed to a central regulating arrangement, and that a temperature value to be determined individually from these actual values is selected and supplied as actual value for the heating regulator.

26. The air-conditioning apparatus according to claims 25, including a moistening arrangement, which moistens the supply air in the supply air channel, in which the moistening arrangement is regulated both in dependence on the room moisture or on the humidity of the exhaust air and also on the supply air temperature.

27. The air-conditioning apparatus according to claim 26, including a first heating device installed in the supply air channel, a cooling device engaged on outlet side of the first heating arrangement in the supply air channel and a second heating device engaged on outlet side of the cooling device in the supply air channel, in which the second heating device is regulated in dependence on the actual value moisture for the desired value moisture.

28. The air-conditioning apparatus according to claim 27, wherein with rising of the actual value moisture over the desired value moisture, the heating performance of the second heating device rises.

29. The air-conditioning apparatus according to claim 28, wherein the heating performance of the second heating device is regulated with a regulator, or with the rising actual value moisture rises exclusively over a predetermined moisture range of the room moisture, with a room moisture before this moisture range, the heating performance has a certain constant magnitude and with a room moisture after the moisture range the heating performance always has a further determined constant magnitude.

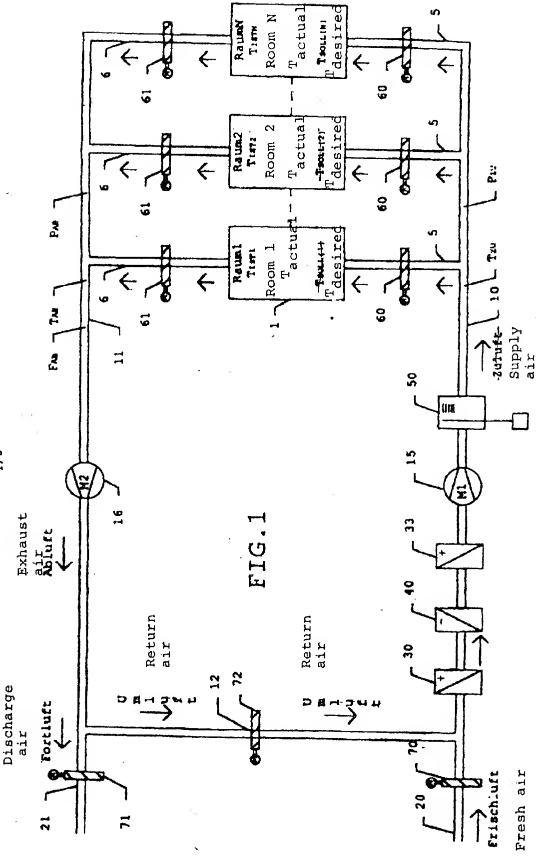
30. The air-conditioning apparatus according to claim 29, wherein the channel pressure of the supply air is not increased during the dehumidifying process.

31. The air-conditioning apparatus according to claim 23 , wherein the fresh air clack valve and the exhaust air clack valve are settable in dependence on the opening setting of the mixed air clack valve.

ABSTRACT

The invention relates to an air-conditioning apparatus which regulates at least the temperature of at least one room to a predetermined temperature desired value ($T_{RAUM\ SOLL}$) by ventilation with heated or cooled supply air. The air-conditioning apparatus has a supply air motor (15) which feeds the supply air over a supply air channel (10) to the room (1) to be air-conditioned, a cooling and/or heating device (30, 40 33) for the cooling or warming of the supply air, and an exhaust air motor (16) which draws the exhaust air from the room (1) to be air-conditioned over an exhaust air channel (11). According to the invention, the desired value ($P_{AB\ SOLL}$) for the regulator of the exhaust air motor (16) forms a room excess pressure established with respect to the outside pressure (P_A).

1/8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Fortluft
Exhaust air
Abluft
Return air
Return air
Umluft
Umluft
Fresh air
Frischluft
Supply air
Zuluft
Raum1
Room 1
T actual
T desired
Raum2
Room 2
T actual
T desired
RaumN
Room N
T actual
T desired
M1
M2
1
5
6
10
11
12
15
16
20
21
30
33
40
50
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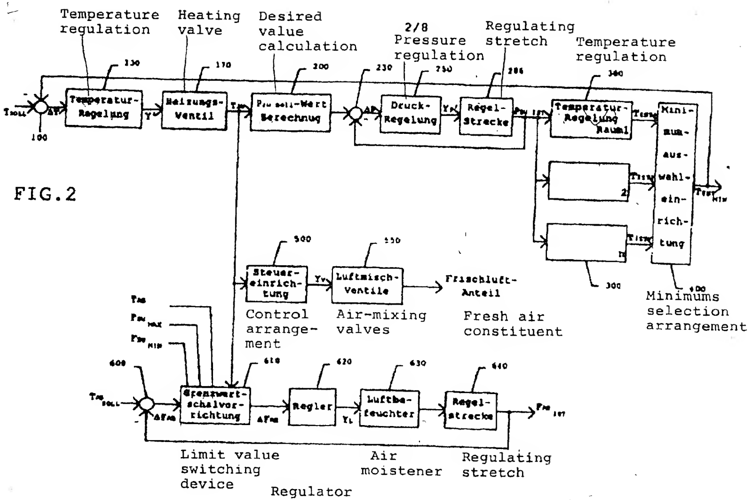
61
70
71
72

FIG.1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Heating valve
Desired value calculation
2/8
Pressure regulation
Regulating stretch
Temperature regulation
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170
200
230
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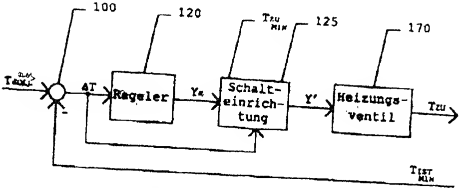
Heizungs-Ventil
Berechnug
Druck-Regelung
Regel-Strecke
Temperatur-Regelung Raum1
Mini-mum-aus-wahl-ein-rich-tung
500
550
Steuer-einrich-tung
Luftmisch-Ventile
Frischluft-Anteil
300
400
Control arrange-ment
Air-mixing valves
Fresh air constituent
Minimums selection arrangement
600
610
620
630
640
Grenzwert-schalvor-richtung
Regler
Luftbe-feuchter
Regel-strecke
Limit value switching device
Regulator
Air moistener
Regulating stretch

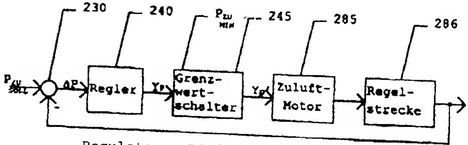
FIG.2

FIG. 3



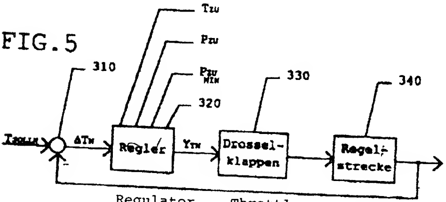
Regulator Switching arrangement Heating valve

FIG. 4



Regulator Limit value switch Supply air motor Regulating stretch

FIG. 5



Regulator Throttle clack valves Regulating stretch

FIG. 6a

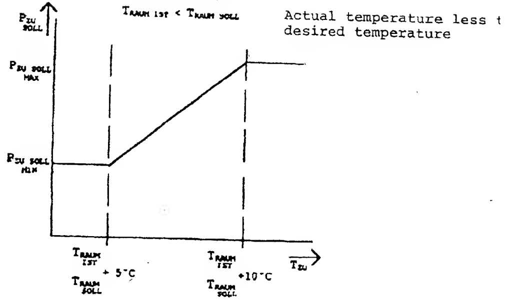

TRAUM IST < TRAUM SOLL
Actual temperature less t
desired temperature
PZU SOLL
PZU SOLL MAX
PZU SOLL MIN
TRAUM IST
+ 5°C
TRAUM SOLL
TRAUM IST
+10°C
TRAUM SOLL
TZU

FIG. 6b

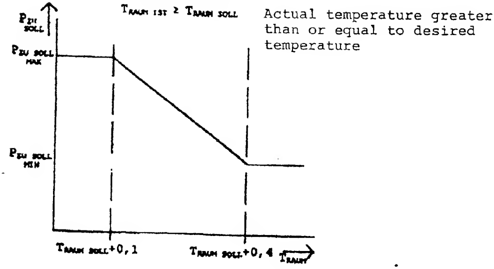

TRAUM IST ≥ TRAUM SOLL
Actual temperature greater
than or equal to desired
temperature
PZU SOLL
PZU SOLL MAX
PZU SOLL MIN
TRAUM SOLL+0,1
TRAUM SOLL+0,4
TRAUM

FIG.7

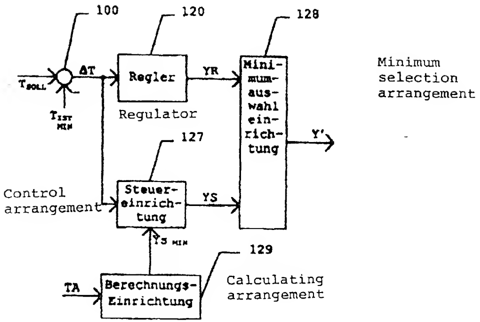

100
120
128
T_{SOLL}
ΔT
Regler
YR
Minimumauswahleinrichtung
Minimum selection arrangement
$T_{IST\ MIN}$
Regulator
127
Y'
Control arrangement
Steuereinrichtung
YS
YS_{MIN}
129
TA
Berechnungs-Einrichtung
Calculating arrangement

FIG.8a

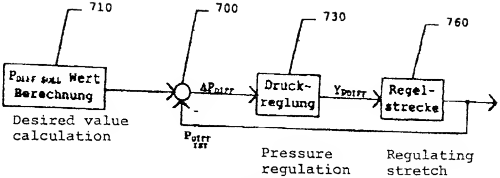


FIG.8b

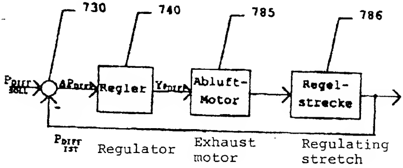


FIG.8c

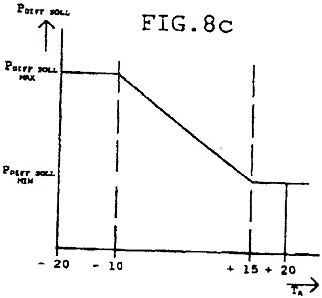
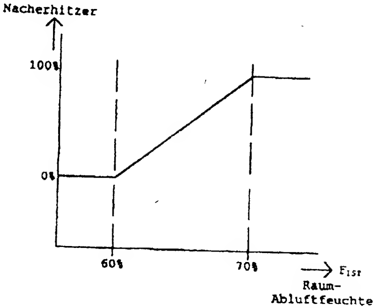


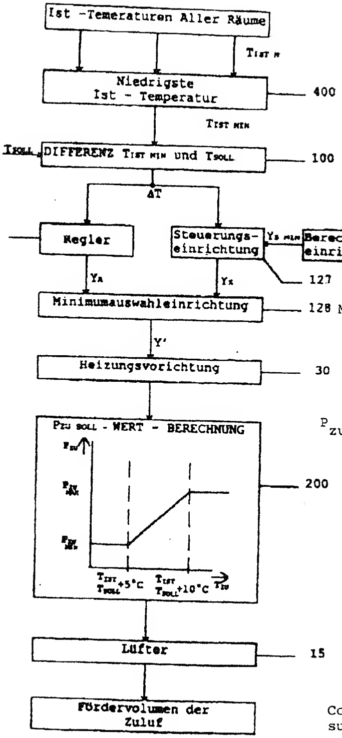
FIG.9

After-heater



Room
exhaust air moisture

FIG.10



Temperatures of all roo

Lowest actual temp ture

Desired temperature diff

Regulator

Control arrangemen

Calculatin arrangemen

Minimum selection arrange

Heating device

$P_{zu\ soll}$ VALUE CALCULATION

Ventilator/Fan

Conveyance volume of the supply air

52.3/C US

ATTORNEY DOCKET NO.: 1704345

COMBINED DECLARATION AND POWER OF ATTORNEY

As below named inventor(s), I/we declare that:

My/our residence, post office addresses and citizenships are as stated below next to my/our name(s); that I/we believe I/we am/are the original, first and sole/joint inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention or design entitled:

AIR CONDITIONING APPARATUS

the specification of which:

___ is attached hereto; or

_X_ was filed on _December 26, 1997_, as Application Serial No. _______

and was amended on ________________________________.

I/we hereby state that I/we have reviewed and understand the contents of the above-identified s ification, including the claims, as amended by any amendment referred to above; and that I/we acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me/us to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I/we hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me/us on the same subject matter having a filing date before that of the application(s) on which priority is claimed:

COUNTRY	NUMBER	DATE FILED	PRIORITY CLAIMED
GERMANY	196 54 542.0	12/27/96	Yes
GERMANY	196 54 955.8	10/15/97	Yes

I/we hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I/we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

APPLICATION SERIAL NUMBER	DATE FILED	STATUS

I/we hereby appoint Robert J. Schneider (Reg. No. 27,383), Jon C. Gealow (Reg. No. 22,386), Davis Chin (Reg. No. 26,854) and Edward Gilhooly (Reg. No. 25,004) all of the bar of State of Illinois, and using the address 111 West Monroe Street, Chicago, IL 60603, my/our attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, and to file and prosecute any international patent applications filed thereon before any international authorities under the Patent Cooperation Treaty and I/we hereby authorize him to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/organization who/which first sends/sent this case to him and by whom/which I/we hereby declare that I/we have consented after full disclosure to be represented unless/until I/we instruct him in writing to the contrary.

It is requested that all correspondence be directed to:

ROBERT J. SCHNEIDER
CHAPMAN AND CUTLER
111 WEST MONROE STREET
CHICAGO, ILLINOIS 60603

I/we hereby declare that all statements made herein of my/our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full Name of Inventor: **Albert Bauer**

Citizenship: GERMANY

Post Office Address:

Residence: München, Germany

Inventor's signature Albert Bauer

Date 13. 1. 1998

EXPRESS MAIL CERTIFICATE

Date November 9, 2000 Label No. EL704549715US
I hereby certify that, on the date indicated above I deposited this paper or fee with the U.S. Postal Service & that it was addressed for delivery to the Commissioner for Patents, Washington, DC 20231 by "Express Mail Post Office to Addressee" service.

Susan Simon
Name (Print)

Signature

File No 582/9-1477

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Albert BAUER

Serial No.: 08/998,507 Group Art Unit: 3743

Filed : December 26, 1997 Examiner: John Ford

For : AIR CONDITIONING APPARATUS

Commissioner for Patents
Washington, DC 20231

REVOCATION OF POWER OF ATTORNEY

AND NEW POWER OF ATTORNEY

Sir:

I am the Applicant or Assignee of record of the entire interest of the above identified application. I hereby revoke all previous powers of attorney or authorizations of agent given in the above-identified application.

I hereby appoint William J. Sapone, Reg. No. 32,518, Henry D. Coleman Reg. No. 32,559 and Neil Sudol,Registration No. 31,669, all of Coleman Sudol Sapone P.C. 708 Third Avenue, New York, New York 10017, U.S.A. as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the Patent and Trademark

Please change the correspondence address for the above-identified application to:

William J. Sapone
Coleman Sudol Sapone P.C.
708 Third Ave 14th Floor
New York, New York 10017
Tel: 1-212-679-0090 Fax: 1-212-679-9121 email wjspatent@aol.com

Bauer Albert 23.10.00

Signature Date

Bauer Albert

Name (Print) (Applicant) (Assignee)

File No. 582/9-1477

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Albert BAUER

Serial No.: 08/998,507 Group Art Unit: 3743

Filed : December 26, 1997 Examiner: John Ford

For : AIR CONDITIONING APPARATUS

Commissioner for Patents
Washington, DC 20231

DECLARATION UNDER 37 CFR 1.132

Sir:

1. I, Albert Bauer, am a German citizen, residing in Munich, Germany, and I am the sole inventor of the subject matter claimed in the above referenced application. I make this Declaration in support of the patentability of my claimed invention.

2. I have reviewed the office action dated July 2, 2002.

3. My invention is directed to an air conditioning system that utilizes means for regulating room pressure, relative to an outside pressure, the pressure regulated as a function of the supply air temperature. Room pressure regulation, in combination with temperature regulation, results in rapid achievement of a desired room temperature, with an increased mixing efficiency of the incoming air with the room air to the point where high air recirculation rates are eliminated, at a considerable savings in energy, yet with significantly improved comfort.

4. I have enclosed as Exhibit A, two drawing sheets which compare my inventive system to a conventional air conditioning system, during winter and summer operation.

5. In the conventional operation, the rate of air flow into the room must be high in order to

achieve mixing of the room air with the inflowing supply air. Even so, a satisfactory mixing is not achieved, and there are cold and warm spots in the room. In the conventional operation, supply air temperature is typically controlled, and variable volumes of air may be delivered but generally the same volume is removed, such that the room pressure is kept substantially constant.

6. In thc operation according to my invention, room pressure is regulated, and mixing efficiency optimized so that the incoming air optimally mixes with the existing room air, so that the inflowing air temperature, or flow rate, or even the points of entry and exit for the air become irrelevant. By slowing and evenly circulating the air masses in the room, warm and cold air tempcraturc pockets can no longer form, and the temperature is more precisely controlled for better comfort. As can be seen from Exhibit A, 100 % fresh air can be supplied, with little temperature conditioning and no recycle, at a considerable energy savings, but no sacrifice in comfort, in fact, comfort is improved.

7. The system in accordance with my invention has been installed in the Munich Philharmonic building, having the largest concert hall in the city. Smoke tests confirmed that the inventive system, including regulating room pressure, could be tuned to supply 100 % frcsh supply air, without drafts, providing a homogeneous mixture throughout the hall, even around the hot light fixtures ncar the stage.

8. The system in accordance with my invention has been installed in the auditorium of Johannes Kepler University, in Linz, Austria, where the differing number of students using thc auditorium presented a challenge. With my system incorporating room pressure regulation, the demands for supplying continuous fresh air could be met, with optimal air mixing and it was reported that there was a decisive improvement in comfort as well as a 47% cost savings in energy consumption over the prior conventional system.

9. The system according to my invention was installed at the Bavarian State Library, where drafts and poor mixing had contributed to an uncomfortable work environment for employees. After converting to the inventive system, unfavorable upward air currents were eliminated and uniform mixing achieved to produce an ideal homogeneous air-mix without disturbing drafts. It was reported that energy savings were around 50 %, and there was a great improvement in staff moral. Employee complaints were reduced as well as employee absences, both attributed to a more comfortable work space.

10. I believe the inventive system as presented in the claims of my patent application is distinguishable from the prior art as these patents all describe what I consider the conventional systems using high recirculation to effect mixing, with no consideration of pressure regulation where room pressure is varied as an integral component of the air conditioning system.

I, the undersigned inventor further declare that all statements herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further, and that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Inventor's Signature

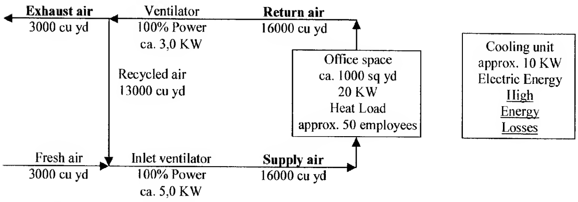
Albert Bauer

Date: 10. 03. 02

Albert Bauer

Summer Operation with a Conventional System

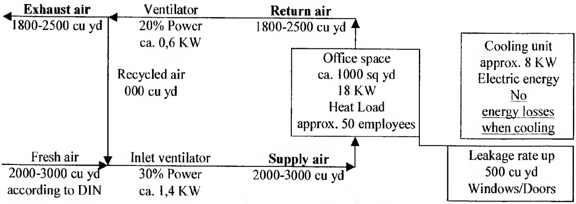
Cool air gathers at the floor!



Without an exception, inadequate air circulation results in high energy losses and an uncomfortable interior air atmosphere!	Return air ventilator = 3,0 KW Inlet ventilator = 5,0 KW Electric energy = 10,0 KW Energy sum = 18,0 KW

Summer Operation with the Bauer Optimizing Systems

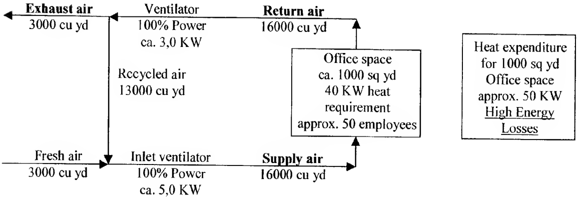
Cooled air flows „on its own“ from the floor all the way to the ceiling!



The more you save, the better your room feels!	Return air ventilator = 0,6 KW Inlet ventilator = 1,4 KW Electric energy = 8,0 KW Energy sum = 10,0 KW

Winter Operation with a Conventional System

Warm supply air remains in the ceiling area!

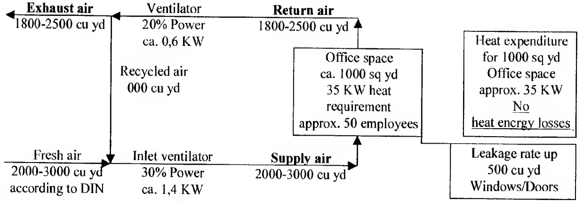


Without an exception, inadequate air circulation results in high energy losses and an uncomfortable interior air atmosphere!

Return air ventilator	=	3,0 KW
Inlet ventilator	=	5,0 KW
Heat expenditure	=	50,0 KW
Energy sum	=	58,0 KW

Winter Operation with the Bauer Optimizing Systems

The warm supply air supply circulates „on it own" from the ceiling all the way to the floor!



The more you save,
the better your room feels!

Return air ventilator	=	0,6 KW
Inlet ventilator	=	1,4 KW
Heat expenditure	=	35,0 KW
Energy sum	=	37,0 KW